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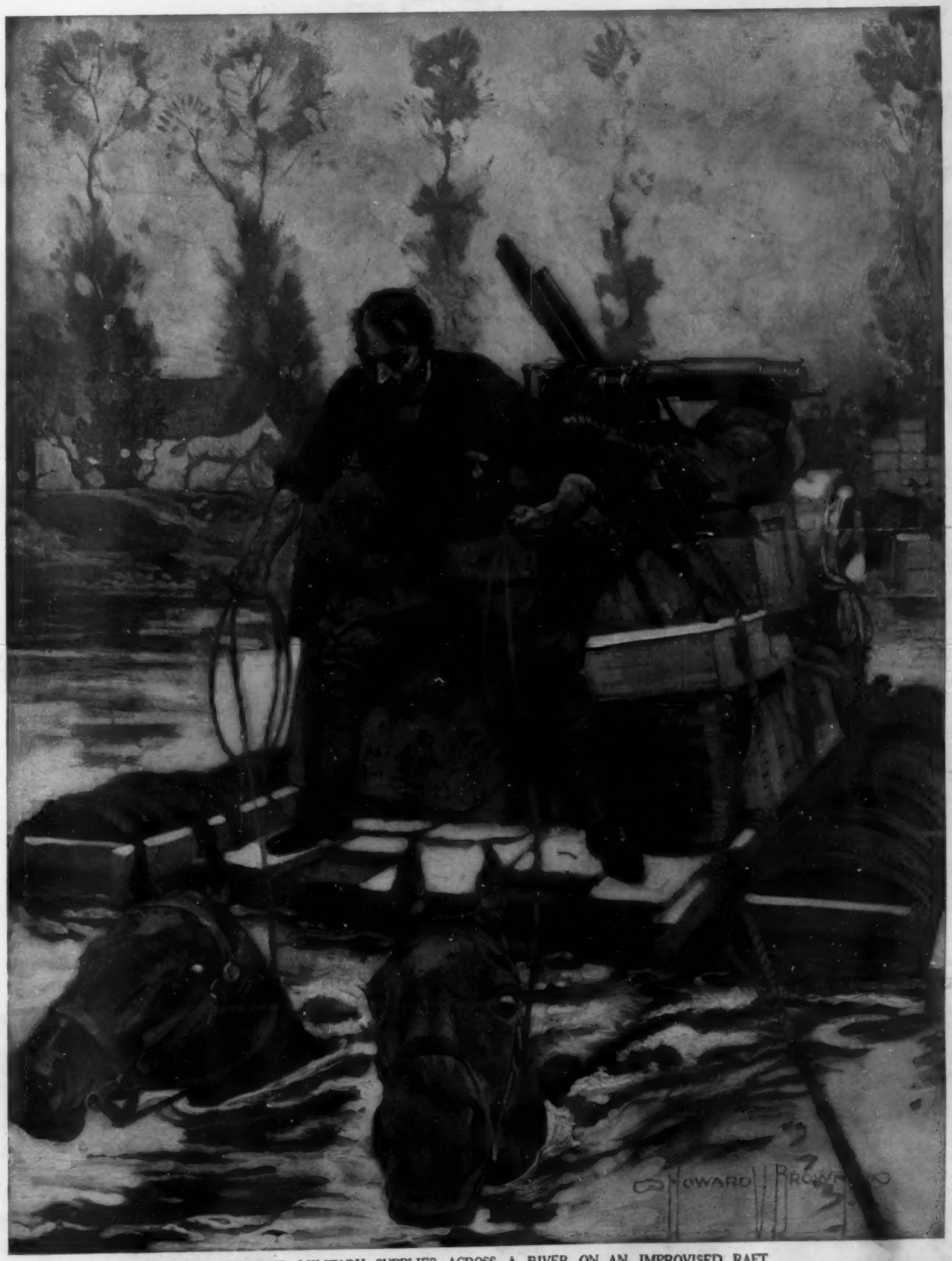

TRANSPORTING MILITARY SUPPLIES ACROSS A RIVER ON AN IMPROVISED RAFT

Vol. CXIII. No. 16
October 16, 1915

Munn & Co., Inc., Publishers
New York, N. Y.

Price 10 Cents
$3.00 A Year

Beats the band how quick Prince Albert rings true to you!

Right off the bat you'll enjoy every puff of a pipe or makin's cigarette that's packed with Prince Albert! *Don't* have to be introduced; *don't* have to fire-proof your tongue; *don't* have to do any old thing but lay-low and hum and smoke-smoke-smoke! The patented process takes care of that—and *cuts out the bite and parch!* If *that* listens, get *this:*

You take this line of P. A. talk at 100% net. Because it fits your taste like a raise fits your exchequer! It cheers up your smoke-appetite most astonishingly—so chummy, so cool, so mild, so mellow, is every fragrant puff of

PRINCE ALBERT

the national joy smoke

Cut loose with a dime, the price of a tidy red tin, or a nickel for a toppy red bag of P. A. Be game! Take a chance firing up your best Sunday jimmy pipe with a load, or roll a makin's cigarette. Let Prince Albert sing it's sunny smoke song in the language *your* tongue and *your* palate will know right quick! Give it a real test-out—and there'll be no doubt about Prince Albert being your little old side-kick in the *immediate* future!

Men, get this information mighty sincere-like. We hand you this Prince Albert word because *it's right!* We know! Smokers all over the nation, all over the world, know how good this brand is; how much actual joy it passes out! Realize, it can't cost you more than the price of a jitney ride, or a dime, for you to *prove to your personal satisfaction* that Prince Albert is absolutely *all* the most ardent enthusiast has ever claimed for it.

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R. J. REYNOLDS TOBACCO COMPANY

Winston-Salem, N. C.

SEVENTY-FIRST YEAR

SCIENTIFIC AMERICAN

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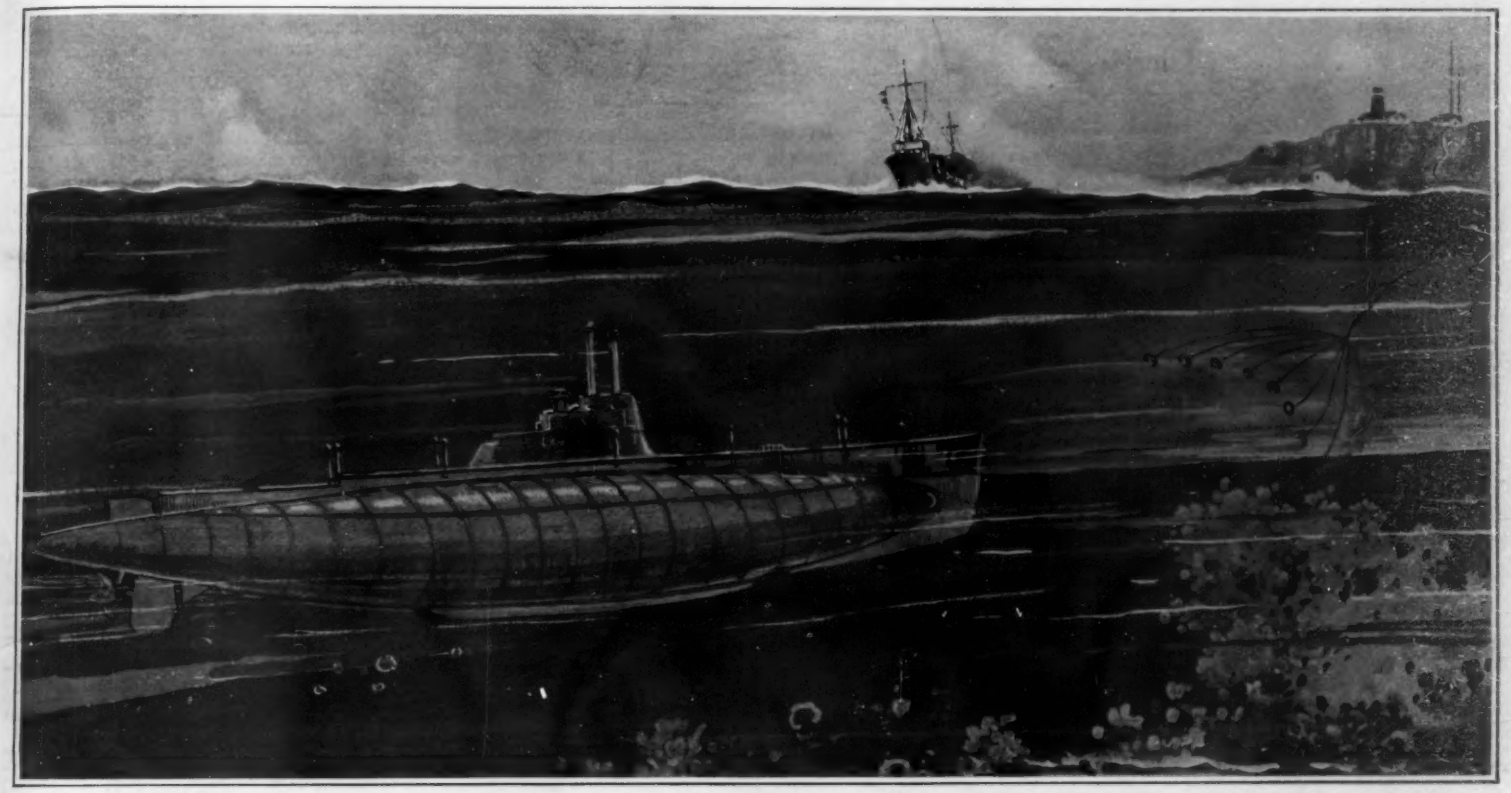

How the coasts of France, England, Scotland and Ireland are now dotted with stations equipped with sub-aqueous microphones for the detection of hostile submarines

Submarines Betrayed by Sound Waves

Detecting the Presence of Underwater Craft Fifty-five Miles Away by Microphonic Devices

THE submarine has long depended for its defensive powers on the fact that, traveling below the surface of the water, it was invisible to the crews of surface ships. Thus it can approach its target without attracting attention to itself and, at the opportune moment, after raising the periscope a trifle above the water to secure its bearings and maneuver into the most favorable position for attacking the enemy, fire a torpedo at a fairly close range.

But while the submarine may be invisible when so desired, it is not noiseless, and therein lies its weak point which has now been made use of in a system for betraying the presence of underwater craft. Not only is it possible at the present time to detect submarines at a considerable distance away, but the same apparatus employed for that purpose can also be used to determine in what direction the craft may be traveling as well as its probable speed. Thus the great advantage of this type of fighting vessel—the very one that is its *raison d'être*—has at last been nullified by causing the ear to detect what the eye cannot.

Since the German submarines entered their unprecedented campaign against the English and French shipping, experts in the latter country have been at work in experimenting with devices for detecting the presence of submarines. But they encountered only slight success. Microphones of various patterns placed in the water caused the detection of revolving submarine propellers several miles distant—but so with the steamer propellers and those of battleships, cruisers, destroyers, motor boats and other craft, not to mention the washing of the water against the nearby shore and thousands of other undesirable sounds. In the babel of sound the original objective was completely lost track of, hence the aforesaid slight success.

At this stage of the experimenting William Dubilier, an American electrical engineer with numerous wireless telephone and wireless telegraph inventions to his credit, at that time in France on the mission of installing wireless telegraph apparatus on aircraft, was called upon to aid in the solving of the submarine detector problem. Dubilier went to Cherbourg, an important French port on the English Channel, where he found Prof. Tissot of the French Academy of Science hard at work on the detector system.

It is obvious to anyone familiar with electricity and sound waves that the problem of evolving a successful microphone system for detecting the presence of submarines by noises peculiar to these craft was a most difficult one. Yet, unless the obstacles are actually met with, it is impossible to form an accurate conception of the great amount of thought and ingenuity that had to be enlisted in evolving a satisfactory apparatus.

In the earlier experiments the French simply placed waterproof microphones below the surface of the water for the purpose of gathering the sound waves and listening to them by means of telephone receivers. At first the sound waves emitted by the propellers of submarines were those sought, but these were found to resemble so closely those of other craft that they could not be relied upon. Fortunately for the experimenters, it was discovered in the course of the tests that the underwater craft were sources of sound waves of exceedingly high frequency, quite distinctive from any other sub-aqueous sounds. While the cause of the high pitched sound is known to the inventors, it cannot be divulged since it would then be possible for German submarine constructors to eliminate the source of the tell-tale sound waves and thus render void the purpose of the detector installations.

Even with characteristic and totally different sound waves available for the detection of underwater craft, there still remained the elimination of all other waves by the experimenters so that the remaining, desired sounds would be available for the determination of the distance traversed by the waves, as well as whether or not the submarine was in motion and if so in what direction it was traveling. While this may seem a quite simple problem, it required several months of careful experimenting and research work in developing suitable resonance tubes for filtering out all undesirable sounds, as well as a tikker or interrupter arrangement to further eliminate all but the desired waves. The tikker device, it is explained by Dubilier, causes only the peaks of the desired sound waves to be heard in the telephone receivers that are used with the apparatus. Many electrical problems had to be solved in connection with the tikker device and its circuit, among them a means of bringing the interruptions in phase with the incoming waves.

The submarine boat placed at the disposal of the inventors by the French government and used in the experiments was detected several miles away by using the apparatus alone. However, it was found advisable to increase the range of the detector system several fold and this was readily accomplished by the introduction of a De Forest audion amplifier between the apparatus and the telephone receivers, ultimately resulting in a range of 55 miles.

The military value of the submarine detector system now used by France and England naturally prevents the disclosure of important details regarding the apparatus and its exact method of operation. However, it is learned that a number of special microphones are lowered into the water to a depth of several fathoms at each station. They are usually arranged in a semi-circle facing out to sea. One connection from each microphone is made to a common wire, while the other connection from each microphone is brought to one point of a multi-contact switch. Each microphone is so placed as to receive sound waves best in one direction. Accordingly, by listening to the sounds received by the different microphones, slowly moving the switch over the several contacts, the operator can determine from the microphone that responds the loudest the direction of the submarine. While the manner of denoting the direction in which a submarine may be traveling is not disclosed, it is safe to assume that this is determined by the decreasing of the volume of sound

(*Continued on page* 346)

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Von Tirpitz and His Navy

VON TIRPITZ has been called "the creator and the controlling mind of the German Navy"—and justly so. To no one man in Germany, not even the illustrious Kaiser himself, does the Imperial German Navy owe so much as to the ever-to-be-remembered Von Tirpitz. To his unflagging zeal, backed by that of his Imperial Master, and rendered popular and nationally effective by the far-flung propaganda of the Navy League, was due the creation, within the brief period of two-score years, of that mighty armada, whose capital ships have now, for nearly a year, swung idly at their moorings in German waters. That his ships should have thus been denied the "freedom of the seas," is no fault of Admiral Von Tirpitz—rather, if we rightly understand the psychology of the German mind, it is due to the monstrous tyranny of a rival state which has dared to set afloat and maintain on the high seas a fleet so vastly superior to Von Tirpitz's effort as to leave him no other alternative than to court absolute annihilation in open battle on the high seas, or to accept, as he has done, a strategical defeat by letting his ships rust at their moorings.

Regarding the German Navy as a whole, it must be confessed that it is lacking in originality. The enterprise and novelty which have characterized the preparation of the war material of the German army seem to have been wanting among the men who have been responsible for naval construction. Von Tirpitz, or the German Admiralty, or whoever it may be, seems to have been content to play the general rôle of copyist; and it must be confessed that the imitation has not been very well done. The SCIENTIFIC AMERICAN has been a pretty close student of naval affairs for the past twenty years, and this lack of originality has formed the subject of comment in our columns more than once. We particularly draw attention to the fact that, right down the line, the armament of the German ships has been lighter and less efficient than that of contemporary navies. In proof of this we have but to point to the ten ships of the "Wittelsbach" and "Kaiser Frederick III" classes, which mount nothing heavier in their main batteries than a 9.4-inch gun. This stupendous error is based upon the mistaken theory that great penetrating and smashing power in the individual gun is less effective than rapidity and volume of fire from a smaller gun. This cardinal error has run right through the whole twenty years of the development of the German Navy, with the result that, ship for ship of even date, the Germans have opposed 11-inch guns to 12-inch, and 12-inch to 13.5- and 15-inch guns of the possible enemy. Fatal, indeed, has been this error. It has left its mark upon all classes of ships, and has been largely responsible for the disasters which have overtaken cruisers, scouts and destroyers when they have encountered the more heavily armed ships of Admiral Jellicoe.

Although Germany had nothing to do with the early development of the submarine, it must be admitted that her technical contribution to naval construction, due to her fine work in the production of oil motors, has been a notable one.

During the early years of the experimental work by other nations, Germany scoffed at the submarine as being impracticable; but when she did take it in hand, and installed her own efficient oil engines, she introduced a class of submarines which to-day are probably superior to those of any other nation. So far as is known, however, outside of building a good engine, the German has made no contribution of great novelty to the submarine art.

Judged by the moral or ethical standards of naval warfare, it must be admitted that Germany has displayed a transcendent originality. Nothing like German submarine methods has been witnessed upon the high seas in centuries of contest for naval supremacy, and in the name of all that is humane and chivalrous, let us hope that the like of it will never be seen again.

The initial successes of the German submarines against the war vessels of the enemy were creditable and perfectly lawful. When the "Aboukir," "Cressy" and "Hogue" were sent swirling to the bottom, followed later by the battleship "Formidable," it looked as if Sir Percy Scott's warnings of disaster were to be fulfilled. Not so, however; for time and the event have proved that against this, as against every preceding new and apparently overwhelming means of attack, an efficient defense will eventually be found. As the weeks passed by, the major vessels of the Allies proved to be safe against submarine attack, except when they were operating in confined waters, as at the Dardanelles and in the Adriatic.

With the break-down of the German submarine offensive against *military* vessels, Von Tirpitz was confronted with a dilemma which might well have brought dismay to any mind less shrewd than his own. On the one hand, was his great fleet of fighting ships held tight in the silent grip of a predominant naval power, and his fleet of submarines baffled in their search for a *lawful* quarry; and, on the other hand, stood the expectant German nation, waiting for the master stroke which should win the freedom of the seas by dealing a mortal blow to British naval predominance. Something had to be done. If England was invulnerable as to her naval supremacy, was there not some other point through which Germany could thrust in the spear? There were the countless fleets of the British and French merchant marine. True; but they were safeguarded from attack by certain humanitarian laws of war, to which Germany was co-signator with other nations of the civilized world.

Well—Von Hollweg under the plea of necessity had torn up one scrap of paper, and so had leaped at the unguarded heart of France. Why not Von Tirpitz also? And thus it came about that the submarine officers were sent out to run amuck among the unarmed merchantmen and fishing boats of the enemy. And so in due course this gallant admiral hung around the neck of the German people the millstone of the everlasting shame of the "Lusitania" disaster.

So entirely unexpected was the attack on merchant shipping, that the losses were necessarily large until defensive measures could be devised. Gradually, and of late very markedly, the toll of lost ships has diminished. Nets, mines, drags, destroyers, thousands of armed trawlers, swift motor boats, watchful aeroplanes and all the devices which scientific research and mechanical skill could devise, have done their work. This last hope of the German Navy has gone the way of all others, and the submarines which have survived the variegated onslaught of the British and French navies are so limited in number as to render the further prosecution of the war against merchant shipping not worth the cost and trouble.

The Efficient Human Machine

THERE is much talk about business efficiency these days. However, any kind of efficiency that does not call for a sound, well-adjusted, smooth running human machine will never be anything else but a spurious efficiency, economically disastrous. The efficiency slogan, to be effective, has got to be a kind of subtitle to the health conservation slogan—which latter is the greatest idea twentieth century medicine has thus far evolved. What can be the use in expecting ideal efficiency in the face of such facts as these: Every third or fourth of us has been dying between fifteen and forty-five, life's economically most productive years of tuberculosis. Consider here the waste—almost too great for the mind to grasp—resulting from our suffrance of this one entirely preventable disease. One among eight of our women dies most cruelly of cancer, after suffering through many months to several years; many such unhappy women have kept working until this physical impairment has made them give up their tasks. Apart from the anguish all must sympathize with, what an economic loss is here represented. Of 20,000 applicants for life insurance, imagining themselves to be in sufficiently good health to get policies, 43 per cent were found to have some kind of heart or kidney or artery ailment. Six hundred and fifty thousand working people die annually of preventable diseases.

The Germans years ago worked out scientifically the relation between human impairments and accidents, with the result that they have cut down the latter at least 50 per cent. The best surety against industrial accidents is an alert mind in a virile body; on the other hand the sure preliminary to accident is an exhausted, devitalized human machine. The corollary here is that a wise corporation, soulless if you like, will ever seek to establish the essential parallelism of efficiency and humanity.

The simple truth is, we Americans are the most extravagant people in or out of civilization, and in nothing more so than in our flesh and blood resources. It is precisely as if many thousands of us were falling blindly over a horrendous precipice, at the bottom of which we have placed the best equipped ambulances in the world, to take us off to the most magnificent hospitals in the world—after we have been hurt. Why is there not now a guarding rail around the edge of that precipice? why are not the danger signals hoisted? so that the finest machinery in the cosmos shall not be smashed beyond repair and carried forthwith to the scrap heap; or have to be mended to 70 or 50 or 30 per cent of its former efficiency, and with a much shorter daily running time than if it had remained whole and unimpaired.

What then is such a railing? What are the danger signals? They are manufactured according to specifications prepared in the science of preventive medicine; and they are figured out on the basis that an ounce of prevention is worth tons of regret, of most unnecessary suffering, of vast material loss. The main idea is to unmask the masked symptoms—the only way to do which is by exhaustive, at least annual examinations of employees. By such means is real efficiency attained; the productivity of plants increased; and length of days assured the valuable employee. Besides, through such periodic examinations the employer will learn how to place his impaired men; how little occasion there will be to discharge them utterly. He will not send a man with a leaky heart to paint a high wall; a weak-lunged man he will take out of a dusty shop and put to outdoor work; and so on.

But here one sounds a warning note. Isn't it a dreadful thing to reveal such impairments? Will not the working man be terrified to learn the truth? Such an argument is about as logical and as merciful as if one should say: "Don't, for heaven's sake, put a lighthouse on those rocks; it would reveal to those aboard ship the awful peril they are in!"

Nothing More to Invent?

SOMEONE poring over the old files in the United States Patent Office at Washington the other day found a letter written in 1833 that illustrates the limitations of the human imagination.

It was from an old employee of the Patent Office, offering his resignation to the head of the department. His reason was that as everything inventable had been invented the Patent Office would soon be discontinued and there would be no further need of his services or the services of any of his fellow clerks. He, therefore, decided to leave before the blow fell.

Everything inventable had been invented! The writer of this letter journeyed in a stage coach or a canal boat. He had never seen a limited train or an ocean greyhound. He read at night by candlelight, if he read at all in the evening; more likely he went to bed soon after dark and did all his reading by daylight. He had never seen a house lighted by illuminating gas. The arc and incandescent electric lights were not to be invented for nearly a half century.

If he had ever heard of electricity he thought of it as the mysterious and dangerous fluid that strikes from the clouds during a thunderstorm. That it could be harnessed to do man's will had never occurred to him.

He never heard the clicking of a telegraph sounder. The telephone would have seemed as wonderful to him as a voyage to the moon. Motion pictures would have reminded him of black art, and the idea that a machine could be invented whereby man would fly above the clouds like a bird, ascending and descending at will, would have seemed to him merely absurd.

The modern printing press, the linotype machine, which seems almost to think; the X-ray, by means of which surgeons diagnose disease and injury and lay out their work with scientific certainty, these things were yet to be invented long after he was dead. He could not imagine the automobile, now so common that they cover the streets and roads of all the world.

He could not dream that a cannon would be made to throw a projectile more than twenty miles, that repeating rifles, revolvers, and machine guns would be invented, that steel monsters of the deep would speed invisibly under the seas with the power to send a giant ocean liner to the bottom within a matter of moments.

He lacked the imagination to see all the thousands and tens of thousands of comparatively small inventions that have come into being since his day, some of them for good and some for evil, but all telling a story of progress of one sort or another. Probably in this he did not differ from most of his fellowmen in his day. It is very likely most of his friends agreed with him that the limit of invention had been reached.

He seems unfortunately deficient in imagination and in optimism, as we read of his letter of resignation in the musty files of the Patent Office. But let us not take too much unction to our souls. We are quite as ignorant of what the next eighty years may bring forth as he was of the future of American inventions.

Notes on the War

The Number of German Submarines.—A German naval officer is authority for the statement that sixty submarines have been put in hand in German and Belgian yards since the outbreak of the war. Of these 24 are of about 250 tons displacement; 12 of about 800 tons; and 24 of about 1,200 tons. According to this authority, over one half have been passed into service and this, at the time the statement was made, gives an average rate of completion of about two boats every three weeks. At the present rate of construction it would seem from these figures that the German statement of their putting out one boat a week may be correct.

The Trans-Siberian Railroad in the War.—When the history of the war comes to be written, one of its most interesting sections will be that dealing with the effective work done by railroads hastily constructed back of the armies engaged. One of the most important works now being undertaken, it is stated, is the double tracking of the great Siberian railroad, a work which will add enormously to the effectiveness of the Russian army, especially during the winter months. Russia has placed an order in this country for 100 locomotives of which 35 have been completed and dispatched to Russia by way of Vladivostok. These will doubtless be used for transporting munitions from Archangel into Russia, before that port is closed by the winter ice.

Starvation That Would Be Fatal.—There has been much loose talk about starvation as a means of ending the war. Thus, there has been the German outcry about the starvation of the German people through the British blockade—something which the German press officials, equally with every other intelligent observer of war, know to be an absolute impossibility. More to the point is the talk about starvation in munitions of war and through lack of the enormous capital necessary to carry it on. If one could sit just now at the meetings of the great general staff of the German army, however, they would find that among these gentlemen there looms up large and threatening, the danger of starvation in men. Including Russia, the allies can put from one and one half to two men in the line against every one by the Central Powers. When the thousand-mile front of the latter becomes too thinly held, it will be broken and the end of the war will be in sight.

The Russian Naval Victory at Riga.—A correspondent, in commenting upon our estimate on the value of the Russian victory at Riga, which undoubtedly has served to delay, if not to defeat, the German operations against the port of that name, claims that we attach altogether too much importance to that engagement and that we have magnified the result. As a matter of fact, the failure of the German attempt, undoubtedly made on a large scale, to force the entrances to the Gulf and land an expeditionary force to co-operate with the left wing of the German army, must be reckoned as one of the most important naval victories of the war. Although the mobile defences, as represented by the battleship "Slava" and the gunboats, did good work, the mainstay of the Russian defences consisted of the system of mines and torpedoes. Indeed, the coast-defence system of this character, in which the Russians are very expert, appears to have been thoroughly effective. It is probable that here, as elsewhere, the Germans' defeat was due to their utter contempt for the fighting ability of the enemy. There is every evidence that the lessons of 1904 have been laid well to heart by the Russian Navy whose naval exploits have been highly commendable.

The Most Powerful Battleship.—In commenting on our recent article comparing the four battleships, "Queen Elizabeth," "Tourville," "California" and "Fuso," the *Army and Navy Military Record* says: "The judgment of the SCIENTIFIC AMERICAN that the 29,000-ton "Tourville" comes in order of value after the "Queen Elizabeth," and is about on a par with the United States "California," has caused some surprise, not so much the judgment in itself as the method at which it has been arrived at. In rating the comparative power of these ships, the American critic assumes they are fighting at a range of 10,000 yards. Now, Paris experts, who from the first have acknowledged the superior ballistic and engineering attainments embodied in the British design and its superior practical advantages for contests at extreme distances, have found some consolation in the firm belief that the "Tourville" type with its formidable battery of 16 heavy guns has no rivals at the ranges of 10,000 meters and under. This opinion, they based on the command of arc and rate of fire of the 4 quadruple turrets and on the penetration and smashing power of the new 13.4-inch shell."

Science

Errors of Precise Leveling.—In a recent discussion of this subject, Mr. William Bowie, of the Coast and Geodetic Survey, stated that very accurate determinations of elevation above some adopted datum had been made possible by the great improvements in the Y-level during the last half century. The International Geodetic Association has defined leveling of high precision as that which has a probable accidental error not greater than 1 mm. per kilometer, and a probable systematic error not greater than 0.2 mm. per kilometer. While most errors are eliminated by the method of leveling, these methods do not ensure against errors due to refraction in leveling on steep slopes; such errors depending upon the time of day and the weather conditions. Recent investigations appear to show that, on an average, an afternoon running gives a greater difference of elevation between two points than a morning running; also that the difference is greater in cloudy than in sunshiny weather, and greater during wind than in calm.

Why the Southern Hemisphere Is Colder than the Northern.—Although most authorities have described the southern hemisphere as only slightly colder than the northern (the annual means, according to Spitaler, being 14.90 deg. C. and 15.2 deg. C., respectively), Dr. G. C. Simpson, the well-known British meteorologist, has recently declared that the southern hemisphere is much the colder, and has explained why. The air is not warmed by the passage of the sun's rays through it, but by contact with the warm ground beneath. In the northern hemisphere there are large masses of land to absorb the sun's energy and give heat to the atmosphere, while in the southern the surface is mainly water. The whole mass of land within the antarctic circle is permanently covered with ice, which is practically a perfect reflector, and thus returns to space most of the solar energy that falls upon it. Dr. Simpson thinks the fact that "5,000,000 square miles of the earth's surface in the southern hemisphere reflect into space a large part of the energy received from the sun" is one of the chief reasons for the difference in temperature between the two hemispheres.

A New Method of Measuring Gravity at Sea has been devised by Dr. L. J. Briggs, of the U. S. Department of Agriculture. It is constructed on the principle of the mercurial barometer, except that the cistern is closed and thus the air within it is not influenced by fluctuations in the pressure of the air outside. The most ingenious feature of the instrument is a device for adjusting the height of the mercurial column without altering its length. This is effected by giving the end of the glass tube a spiral form and making it sufficiently flexible to allow a slight vertical adjustment by means of a micrometer screw. Thus the volume of the enclosed air and the volumes of mercury in the tube and the cistern, when the instrument is set for an observation, are the same as at any other observation. Finally, the whole apparatus is surrounded by melting ice, and is thus kept at a constant temperature. The height of the mercurial column, after adjustment, as read from the micrometer head, serves as a measure of the force of gravity. The apparatus is swung on gimbals to ensure verticality, and hung from spiral springs to reduce vibration. Daily observations with the apparatus on a voyage between Tahiti and San Francisco indicate a slight excess of mass in this part of the ocean, particularly in latitude 16 deg. to 24 deg. N., and longitude 130 deg. to 135 deg. W.

Geological Survey Maps for Sale at Postoffices.—The great series of topographic maps which the U. S. Geological Survey has had in course of publication for many years, and which will ultimately cover all parts of the United States, has undoubtedly been less widely used by the public at large than it deserves to be. Nearly two fifths of the country has now been mapped, including the whole of Massachusetts, Connecticut, Rhode Island, New Jersey, and the District of Columbia, and portions of every other state in the Union. For 10 cents anybody living in a region for which the mapping is complete can obtain a chart of his locality on a scale large enough to show the principal roads, as well as every brook, pond and hill of any consequence. Altitudes are shown in great detail by contour lines. The general utility of such maps is obvious, and in order to give them a wider circulation the Survey has adopted the plan of sending a sample copy of each new map to the postmasters in the area covered, with the suggestion that they tack it up in a conspicuous place in the postoffice. A small stock of maps is also sent to each postmaster for sale. The postmaster receives a commission for his services, and the public is enabled to buy the maps without writing to Washington. One postmaster in Minnesota reports having sold 125 maps the first month he handled them.

Radio Communication

South African Time Signal Service.—According to a report received, there has recently been inaugurated at the Union Government wireless station at Slangkop a radio time signal service for the convenience of mariners in South African waters. The signals will be sent out daily. The stations at Cape Town and Durban are operated during the 24 hours of each day and send signals of 600 meters wavelength. At 11 o'clock (Union time—9 o'clock Greenwich time) at night, time signals are emitted by the Cape Town station, extending over an interval of 30 seconds. The time signals are preceded by the usual warning signal.

Approach of Storms Detected by Coherer Device.—A revival of the long abandoned filings coherer used so extensively in the pioneer days of radio communication is presented in the novel form of an electric storm detector used at the Waterside station of the New York Edison Company. Briefly, the equipment comprises a filings coherer, a sensitive relay, a decoherer for restoring the filings to their normal, loose state, and an alarm bell. Long before a thunder storm is within hearing distance the sensitive coherer operates the alarm bell and gives warning to the power station attendants of the increase in load that is to follow. It is said that during some storms when it becomes quite dark the load is increased over 60,000 kilowatts in the course of 5 minutes' time. It is obviously necessary for the attendants to have ample warning so as to be prepared to take care of the sudden load that is thrown on the generators.

Receiving Set Operated by Push Buttons.—A New York inventor has just introduced a distinct innovation in the field of radio communication, which is in the form of a receiving set operated by 10 push buttons or keys. The various steps in tuning the different components of the set are accomplished by the manipulation of the keys; a 12-volt motor operating the coupling mechanism of the receiving transformer and regulating the amount of inductance included in the primary and secondary circuits, according to the keys that are depressed by the operator. Two smaller motors are employed for operating the two variable condensers that take care of the finer degrees of tuning. Dials placed in front of the instrument indicate the amount of coupling, inductance or capacity being used at any moment. The set tunes to 12,000 meters wavelength, and from the minimum to the maximum adjustment of all the instruments, only 12 seconds are necessary.

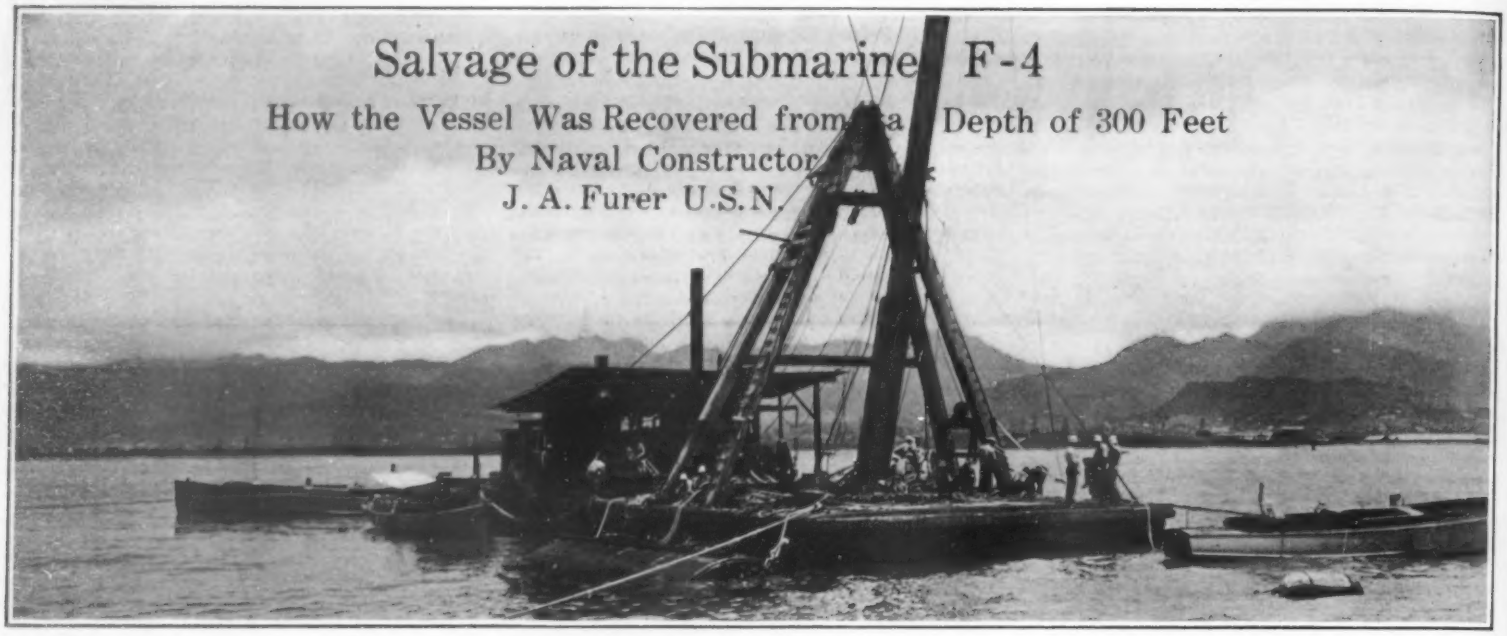
Improvements at the Sayville Station.—At the beginning of the European war the Sayville wireless station, situated on the southern shore of Long Island, was equipped with a wireless transmitter rated at 35 kw. With the severing of her cables Germany found it necessary to rely on this station, as well as another powerful plant at Tuckerton, N. J., for communication with the United States. And the difficulty of transmitting and receiving radio messages through the unfavorable atmospheric conditions prevailing during the summer season soon proved the original transmitter insufficient for reliable and constant communication, with the result that more powerful equipment was decided upon. Since then, three 500-foot towers have been added to the aerial system, and the original transmitter has been replaced by one of 100 kw. rating; the present station being equipped to insure uninterrupted service with the German station at Nauen (near Berlin), irrespective of atmospheric conditions short of a thunderstorm in the immediate vicinity of either station.

Increasing Wireless Ranges by the Use of Kites.—Promising results were recently secured by the United States Signal Corps while experimenting with wireless aerials suspended from box kites during maneuvers in Massachusetts. Although the average range of a set using the portable mast and antenna is 25 miles, it was found possible to transmit messages 150 miles with the same set attached to an antenna suspended from a string of box kites elevated to 6,600 feet. Not alone the transmitting range but the receiving radius as well was materially increased with the use of the kite aerial; messages from the Government station at Arlington, Va., as well as from a station at Bermuda, being intercepted. It is planned to conduct extensive experiments with kite antennæ, and present opinions are that the average range of the army field sets will be increased anywhere from 6 to 16 times. The use of kite aerials is not a novelty in radio communication, for they were used in the very beginning of the art and many times since. Numerous factors render the employment of kite antennæ uncertain and often unsatisfactory, but with the appearance of kites of new design there is a strong possibility of obviating many of the present obstacles.

Salvage of the Submarine F-4

How the Vessel Was Recovered from a Depth of 300 Feet

By Naval Constructor
J. A. Furer U.S.N.



Pontoon alongside the wrecking scow ready to be sunk

UP to the time the F-4 was lost, the United States Navy had been entirely free from serious submarine accidents. In fact, our navy was the only one operating any considerable number of under-water craft which had not lost one or more such vessels.

The four submarines of the "F" class had been operating in Hawaiian waters since August, 1914. On the morning of March 25th, 1915, at about 9:15, the F-4, preceded by the F-1 and F-2, stood out of Honolulu Harbor for a submerged run. On the way out, the F-4, running submerged, but with periscopes showing, passed the F-1, standing in on the surface. The commanding officer of the F-1, noticed that the periscopes of the F-4 were trained on him and waved his cap in acknowledgment. That was the last signal exchanged by the doomed vessel with the living world.

The other two submarines returned to the harbor shortly, but when the F-4 had not returned by 10:30 A.M., the officer of the deck of the tender "Alert" became alarmed and reported the fact to the Commanding Officer. A fast motor boat was promptly dispatched to search the harbor fairway for any signs of the vessel. The other three submarines and all the power boats of the "Alert" presently joined in the search. In the meantime, also, men had been stationed to listen in on the submarine signal sets of the "Alert" and of the other vessels. This watch was kept for days, but not the slightest sign of life was ever received from the lost submarine.

At about 12 o'clock one of the vessels came across quantities of air bubbles and an oil slick on a range approximately between Diamond Head and Barber's Point. The chart shows 1,200 feet of water in this locality. Had this spot been the resting place of the F-4, there would have been no use in attempting to bring her to the surface. However, the oil seemed to come from inshore, which left some hope that the vessel might not lie beyond the depth of human assistance.

The ocean floor rises very steeply to form the Island of Oahu, as it does around all of the islands in the Pacific Ocean which are of volcanic origin. Only a few hundred yards inshore from the locality covered by oil, soundings gave a depth of about 300 feet. This was encouraging and left a chance that the vessel might not be in the very deep water indicated by the first bearings.

Two divers from the submarine flotilla made a descent in this vicinity to a depth of 190 feet without reaching bottom and without seeing anything of the F-4. These men went down under helmets only,—this as a matter of choice, because of the somewhat greater facility in coming to the surface in case of an accident to the air supply. This depth was later exceeded by one of the divers who descended to 215 feet under a helmet alone, but again without reaching the bottom or seeing the vessel. A descent to this depth, with air supplied by a pump, is probably a record. The return of this diver without suffering from acute caisson disease or other physical impairment is almost miraculous.

The only possible chance of saving any lives,—if the men survived the accident at all,—was to drag the craft into shallower water. This was known to be feasible only in case the living and machinery spaces of the submarine had not been filled with water. With the vessel completely waterlogged, her weight would have been more than 260 tons. This was no doubt actually the condition of the submarine within a few hours after the accident. There was, of course, not the slightest possibility of dragging any such weight in shore and up hill. To have made no attempt at dragging would, however, have meant giving up all hope of saving the lives of the crew at once, because no lifting gear could be improvised and made fast at a depth of 300 feet, within the time available for rescuing the men.

Tugs were brought to the scene of the accident to drag the bottom. For this purpose, a sweep about 2,000 feet long was made of chain and wire cables. Two tugs towed at each end, parallel to each other, and about 400 feet apart. One account of the great depth of the water, a very long sweep had to be used to insure its dragging the bottom. It was difficult to determine, even approximately, the location of the submarine, because the air bubbles showed only intermitteptly and the oil slick soon spread over a very large area.

During the night a microphone was constructed on the "Alert" for sounding the bottom and detecting the vessel in case of contact. This apparatus consisted of two sounding leads strapped together. Into the bottom of each lead a nail was driven. Electric conductors were connected to the nails and fitted to a telephone receiver. A number of dry cells were wired in to complete the outfit. On bridging the two nails with a metallic object, the circuit through the telephone receiver was completed,—recording a click.

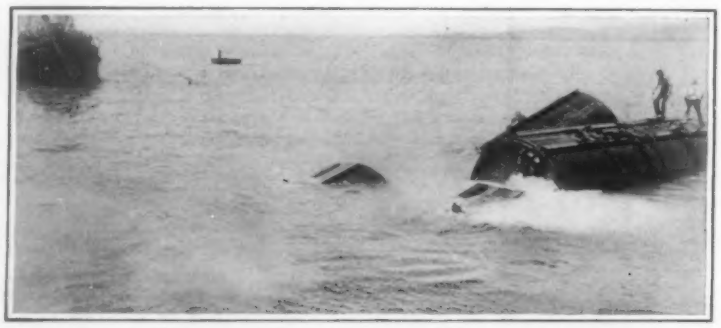
After dragging the sweep back and forth over the bottom all night, it caught firmly under the vessel about noon the next day. A good many strikes had been made previously, some of which may have been around the top of the submarine, but slipped off. The only evidence that the vessel had been caught was that air bubbles again appeared in the locality where they had been previously noted. Also, by sounding with the microphone over this area, a large metallic object was located which was correctly assumed to be the submarine. The depth of water around this spot varied from about 295 feet to 315 feet. The position was plotted and the vessel found to be lying about a mile and a half from the harbor.

All efforts to drag the vessel in shore were, however, fruitless. Even after applying an upward pull of about 100 tons, by means of a dredge, and towing in shore with all the power available, the submarine could not be moved. This was the final confirmation of the belief that the vessel must be completely filled with water. While these attempts at rescuing the crew were being made, steps were being taken to salvage the vessel by lifting. No ready-at-hand salvage gear of any description was to be had in Honolulu. This was not, however, a particular handicap, because none of the usual salvage methods could have been applied in any case, on account of the great depth of water in which the vessel lay.

For the main units of the salvage plant, two substantially built mud scows, 104 feet long by 36 feet beam, were selected. The use of the scows strictly as pontoons—that is, the employment of their buoyancy alone for lifting—was ruled out, because there is practically no tide off Honolulu.

Windlasses were improvised instead, for lifting. Five 30-inch I-beams were first of all laid across the mud pockets so as to transfer the large concentrated loads to the fore and aft framing of the scows. Fortunately, heavy shafts could be procured in Honolulu, as they are used in the sugar mills, and are consequently carried in stock by the machine shops. Shafts 13 feet long by 14⅝ inches in diameter were selected for the windlasses,—the lifting slings being wound up directly on the shafts. These shafts were supported by three cast-iron pillow blocks secured to the I-beams. Two windlasses were fitted side by side on each scow so that two slings might be used under each end of the vessel. It would have been quite impossible to obtain a single wire hawser of sufficient strength to carry one end of the submarine under the live load conditions to which the slings were subjected.

A hoisting engine was installed on each scow for winding up the slings. These engines were, naturally, not powerful enough to do the work without a large purchase. In the case of one scow, the power had to be multiplied 18 to 1, and, in the case of the other,—which had a



F-4 coming up, bow pontoons on surface, middle pontoons just emerging

Towing the F-4 suspended from the pontoons

smaller engine,—36 to 1. This was accomplished for each windlass by reeving up a triple-sheave tackle with ¾-inch wire rope leading to one of the engine drums. To the traveling block of the tackle the winding spool rope (as shown in one of the photographs) was shackled. This rope was wound up by hand on a spool which was driven on to the square end of the windlass shaft. By unwinding this rope by power, the requisite turning effort was applied to the windlass shaft. As soon as the two blocks of the triple purchase came together, the spool rope was unshackled from the traveling block,—rewound on the spool by hand, the triple purchase overhauled, and again shackled to the rope, ready for another lift. During this fleeting process the windlass shaft had to be kept from turning backward. This was accomplished by slipping a nickel-steel locking pin through a hole in the spool,—as shown in one of the photographs,—and backing down until the ends of the pin rested on pillow blocks provided for the purpose. Four locking pin holes were bored in each spool.

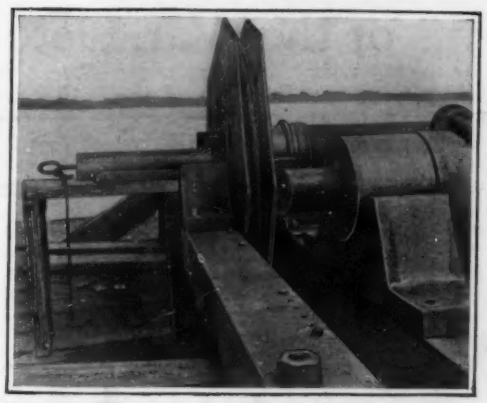
The construction of the winding spools was one of the most bothersome features of the design, because of lack of manufacturing facilities. A steel casting plant was not available. Cast-iron could not be trusted, as the stresses to which the spools were subjected in service were very great. They were therefore built up solid of steel plates. The core was made of ten ½-inch plates in the absence of any heavier available material, the side plates being of ¾-inch material. All were riveted together and the core lined with Douglas fir. As the diameter of the spools was 50 inches and the diameter of the windlass barrel 15 inches, a multiplication of power of better than 3 to 1 was obtained.

The ends of the hoisting cables were secured by means of hook bolts passing through holes in the windlass shafts. These bolts were 2½ inches in diameter. By setting up on the nut at one end of the bolt, the hook was drawn down over the cable so hard that friction prevented the end from slipping through. The end was also backed up by cable clamps and three dead turns of the lifting hawser allowed before taking up the load. The length of the scows limited the travel of the running block of the triple purchase to about fifty feet. This consequently limited to three turns the number of revolutions of the windlass shafts obtainable without rewinding the spool rope. The windlasses then had to be locked, the blocks overhauled and the rope rewound. This was the condition on the scow having the more powerful engine. On the other scow, on account of the introduction of a luff to increase the purchase, only one half turn of the shaft could be obtained between fleets. While this method of lifting promised to be very slow when the design was evolved, it developed to be an insignificant item in the total time consumed in the salvage operation. On one occasion the submarine was lifted 58 feet in less than two hours after all the preliminary work of preparing to lift had been completed. This preliminary work took 21 days.

In designing the gear, shafting, and supports, the live load conditions due to the almost continual swell had to be reckoned with. If the assumption could have been made that 260 tons of dead load would be distributed equally among four lifting slings, the design could have been much simplified. Instead of that, the assumption had to be made that half the weight of the vessel would come as a live load on a single sling at times. That this assumption was not extravagant was fully demonstrated during the salvage work.

Two steam-driven pumps were installed on each scow, so that in case it should become necessary to use more power for starting the submarine off the bottom than could be delivered by the hoisting engines the buoyancy of the scows could be called on. The buoyancy of the scows had to be called on only once, however.

A dredge, from which the boom and bucket gear had been removed, was used as the central unit of the salvage plant. This dredge was selected because it was equipped with a 10 x 14-inch engine geared to six drums, any of which could be operated independently of the others. This dredge was anchored near the submarine. After sweeping the lifting hawsers under the submarine, the ends were taken to the dredge and hove in by means of the drum wires,—thus mooring the dredge over the vessel. The gearing between the engine and the drums was such that a very considerable pull could be applied to the hawsers, as was frequently necessary in order to make the lines render under the hull of the submarine to the desired position.



Winding spools of windlass—Locking pin at left

Search was made while the scows were being rigged, for hoisting cables of requisite strength to carry the loads. Cables of these dimensions are not carried in stock by manufacturers, and, as was to be expected, had to be picked up here and there. Only one cable could be located which was entirely satisfactory. This was a plough-steel wire 2⅝ inches in diameter. For the other three slings galvanized steel cables 2½ inches in diameter, and plough-steel 2 inches in diameter had to be used. One of the chief difficulties in handling hawsers of such size is their weight and stiffness. The 2⅝-inch plough-steel cable weighed over seven tons and was not much more flexible than a bar of iron.

Within a few days after the accident, the Navy Department started a party of divers from New York for Honolulu to assist in the salvage operations. The Bureau of Construction and Repair had been conducting experiments for some time on deep sea diving. Even though the divers could do very little work at a depth of 300 feet, their services were needed to report on the position of the lifting hawsers so that they could be shifted intelligently to the desired locations.

Contrary to the general belief, a special suit is not worn for deep sea work. The diver is subjected to the full pressure corresponding to the depth in which he is working, as is the case in ordinary shallow water diving. The difference between the deep sea procedure and the shallow water procedure lies merely in the method of supplying air, and in the scientific restoration of the diver's body to a normal state of equilibrium while returning to the surface after having been subjected to abnormal pressures. Air for deep sea work is supplied from storage tanks,—the pressure being regulated from above, according to the depth at which the diver is working. In this instance a number of torpedo flasks were charged to a pressure of 2,250 pounds. The air is supplied to the diver's helmet through the usual hose line after being passed through a reducing valve. The diver also has control valves so that he can regulate the air supply. By means of the helmet valves he can make himself lighter or heavier at will. When the submarine was in 300 feet of water, the pressure to which the diver was subjected when on the bottom was about 135 pounds to the square inch.

The rate at which the diver is brought to the surface is fixed by the length of time he was exposed to any given pressure. For example, the first diver to go down on this job made the descent in five minutes and was on the bottom at a depth of 306 feet for twelve minutes. He was then brought back to the surface in one hour and forty-five minutes to insure gradual decompression.

The diver is allowed to come up fairly rapidly until a depth of 100 feet is reached. A Jacob's ladder of this length, with rungs spaced 10 feet apart, is sent down to him so that when he reaches this depth in his ascent he can rest on the lowermost rung. The diver is required to stop on each rung for the length of time called for by certain tables which have been worked out from experimental data. Decompression is in this manner accomplished slowly enough so that he will arrive at atmospheric pressure restored to normal condition.

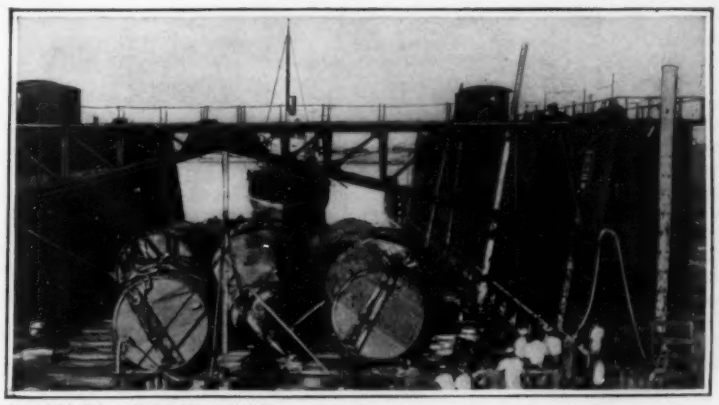
Although the diver does not become conscious of fatigue while working under great pressure much sooner than if he were working near the surface, the exertion is, nevertheless, much more exhausting. This was demonstrated in the case of a diver who remained on the bottom 30 minutes, trying to pass a small reeving line,—the only actual manual work at this depth which was attempted. According to the diver's statement, he was not conscious of becoming fatigued while on the bottom, but after coming to the surface he collapsed from exhaustion and did not regain his strength for 3 or 4 days, notwithstanding the fact that the man was a perfect physical specimen.

After innumerable difficulties the 4 wire hawsers were placed under the submarine in the desired locations and the ends made fast to the windlass shafts. As was feared, however, the strength of the cables became impaired rapidly, owing to chafing, where they passed around the bilges of the vessel. After lifting about 25 feet and towing inshore to a new landing one of the smaller hawsers parted. While it was being replaced, bad weather set in, and presently all of the other hawsers parted likewise. Just one month from the date of the accident not a line was around the vessel and the only measurable progress was a reduction in the depth of water from 300 to 275 feet.

However, the adequacy of the lifting gear had been demonstrated as well as the feasibility of sweeping lines under the vessel. It was now obvious that wire hawsers could not be counted on to resist the chafing action caused by the more or less continuous swell. Four slings were made up instead, of 90 feet of 2⅝-inch chain into the ends of which the wire hawsers were spliced. By having only chain in contact with the hull of the vessel the stranding of the wire hawsers was avoided. Chain causes more damage to the plating of a vessel when so used than wire. For this reason that type of sling was ruled out originally. Great difficulty was experienced in getting the new slings in place, as the former method of sweeping by means of two tugs was impracticable, but they were finally worked to the desired locations.

The vessel was lifted 225 feet in a few days, once the slings were in place, and towed inshore to a spot just off the channel entrance where the depth of water is only 50 feet. Preparations were being made for a final lift which would have brought the submarine high enough to permit entering the channel and landing the vessel in a floating dock in the harbor. Only a few hours were needed for this work, but in that short space of time a heavy ground swell set in and wrecked the operations. High surf waves built up in an incredibly short time which caused the scows to charge back and forth so violently that the shell plating of the submarine gave way under the forward slings. All the lines had to be let go in order to save the vessel from becoming

(Concluded on page 346)



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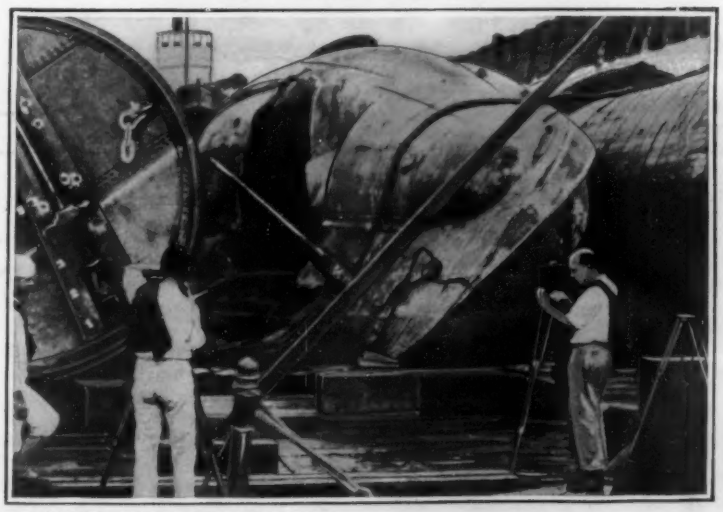
The F-4 and pontoons in dry dock



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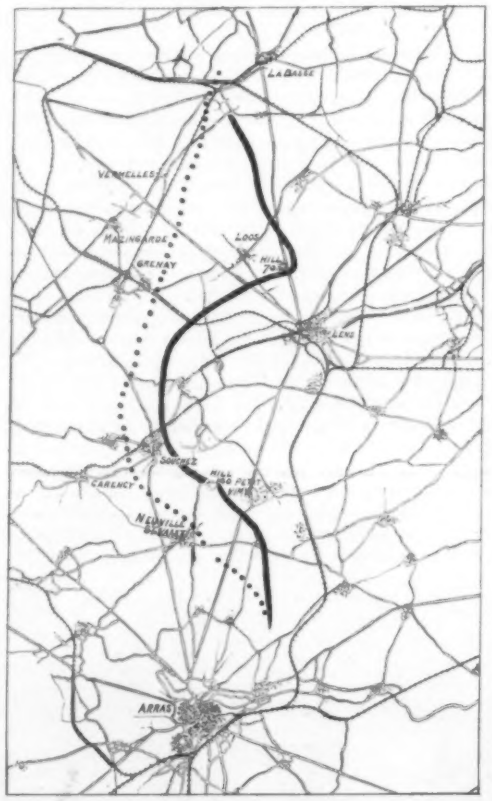
The large hole torn by the slings through the shell plating

Strategic Moves of the War, October 7th, 1915

By Lieut. J. B. W. Gardiner, Formerly of the 11th Cavalry, U. S. A.

THE public interest, during the past ten days, has shifted from the operation in the eastern theatre to the western, where the popular imagination was stirred by the almost unheralded offense of the Allies north of Arras and in Champagne. The western battle lines, except for intermittent artillery duels, had been lying dormant for months and, as artillery duels not followed up by infantry attacks can be productive of no change in position, was utterly devoid of interest. All during the week ending September 25th the artillery of both the Germans and the Allies was more active than it had been for months. It was evident that a movement by the Allies was in the air since they were the aggressors. On the morning of the 25th the fire of the Allies concentrated in the Champagne and in the section north of Arras showing clearly that these were the points of attack. In order that these movements may be clearly understood in their relation to the entire front, they will be taken up in detail. In the first place, it must be realized that no general drive against the German line is possible. The line is entirely too strong, the disparity in numbers is not so great as to give such a movement a sufficient probability of success, and the loss of life would be all out of reason compared to the results achieved. For even if the Germans were driven out of France by an army which when the German border was reached found itself exhausted and depleted to the point where a further offense was impossible, the Entente would find itself no nearer a satisfactory solution of the war than before—as has been repeatedly stated by military critics not only in relation to this war but to all wars, the objective of every field army is not territory but men—the army of the adversary. If after any operation vast territory be gained but the opposing army itself is still intact, still capable of resisting and striking back, the operation has not been a success in its relation to the object for which the war is being waged. The present situation in the eastern theatre is ample proof of this contention. This inability to drive over the entire line being recognized, the next point is the determination of an alternative. Again let us turn to the eastern theatre to see how a similar condition has been met. A front, containing some important and greatly desired post is selected, and by making use of available highways and railroads a concentration of men and artillery is effected at each extremity of the selected front. An attack is then launched, the flanks of the opposing line are bent back and the creation of a salient results. It is obvious that if the advantage can be followed by striking against the side of this salient, the troops holding it must, if the side give way, retreat or be captured. This is the German strategy which has won for German arms so many square miles of Russian territory. And this is the strategy which the French will use in their efforts to drive out the invaders. A glance at the accompanying map clearly illustrates the point. The town of Lens, the great coal center of France, a point of crossing of important railroads and highways, was the desired post. The front selected was between Vermelles and Neuville St. Vaast. After a terrific artillery bombardment, exceeding in violence even the British attack against the trenches of Neuve Chapelle, the Allies rushed forward, the British from Vermelles, Mazingarde and Grenay, the French from Souchez and Neuville St. Vaast. Passing through Loos, after terrible hand to hand fighting in the streets and in the cellars of the demolished houses, they took possession of Hill No. 70, just a mile and a half northwest of the City of Lens, which completely dominates not only the city but all its northerly and easterly approaches. At the same time the French infantry also charged forward advancing through and beyond Souchez to Hill No. 119, and from Neuville St. Vaast to Hill No. 140, and the heights of Petit Vimy. The situation thus created is apparent from the map. A deep salient has been created, the tips of which, measuring from Hill No. 70 to Hill No. 140, are only 6 miles apart. Both of them are, moreover, commanding positions in every sense of the word. If these points can be held against the German counter attacks which are being directed against them with all the energy and strength the Germans can bring to bear, nothing can prevent the Allies from occupying the territory embraced by this salient. The approaches are under constant fire, the German line itself is subject to a plunging fire from flank, front, and rear and part of it is enfiladed. The Allies have the advantage of position as they hold practically all of the higher hills and any forward movement they make will be down hill, as east of their lines the ground slopes rather rapidly to an almost flat plain. At the first indication of an advance from either or both sides of the salient, the Germans holding it must retire or face inevitable capture. The Allies loss has been great it is true, but the German loss has been greater; and the Allies have the greater reserve in man power. The ultimate object of the Allies must be the railroads paralleling the German front which on this part of the line run north and south, as it is by means of these lines that the Germans effect their reinforcements and their concentrations. An analysis of the railroad situation from this viewpoint will be made at a later date.

In Champagne the means employed in the advance were entirely different—due to the difference in objective. Here there was no one point which was coveted by the Allies as of strategical or economic importance. Rather there was a line which was wanted—the railroad line from Challerange near the westerly edge of the Argonne Forest to Bazancourt northeast of Rheims. The strength of the German position in the Argonne and in Champagne has been in great part at least due to the facility with which troops could be shifted from one point to another as



Vicinity of Lens—Old line shown by dots, new by solid line

occasion demanded. This was due to the railroad running in rear of and almost parallel to their line between these points. It also greatly simplified the problem of supplies of food and munitions. This railroad is that mentioned above and is the only road for a distance of 15 or 20 miles that can fill these functions. With this railroad in French hands, there is no way for the Germans in the Argonne to reach the Champagne line except by way of Sedan, and by a very roundabout way to Vouziers. The distances involved over this route are so great that for strategical purposes the road to Sedan may well be considered valueless to the Germans in their present position. In this connection it is well to remember that this is a war for railroads. The demands made on transportation are so enormous, because of the vast quantities of artillery ammunition that modern fighting requires and also because of food and other supplies needed for the vast armies employed, that railroads as a means of effecting such transportation are not a relative but an absolute necessity. The Germans, of course, thoroughly appreciated the advantage to them that lay in the possession of the Challerange-Bazancourt line and the section of their front in Champagne was, as the French had found out in the fighting of last February, one of the strongest on the whole front. So heavily was this section manned that the French captures alone averaged 1,000 men for each mile of front they attacked. Not only that but it was so heavily fortified and so well defended by field works to which German engineers had given the character almost of permanent fortifications that it was considered impregnable. Nevertheless the French stormed it, first with a deluge of shell and then with infantry and advanced to within 2 miles of the railroad where they dug themselves in and are now apparently thoroughly entrenched. In one place, in fact, they actually crossed the road but were driven back. As a means of German communication, however, the usefulness of the railroad has been seriously impaired, though not totally destroyed as it now comes under French artillery fire at short range. In the Champagne as in the Arras section the French have done much to justify the losses they have sustained. Their objective in neither case has been attained, but their advance has been sufficient in both cases to bring the object of their attacks if not actually within reach, at least within their control. The German press for political reasons has been inspired to discount the value of the French advance. This is not only natural but expedient. If the Allies can hold what they have taken, however, the value of their advance will soon become apparent.

Death of William Watson

WILLIAM WATSON, Secretary of the American Society of Arts and Sciences since 1884, died on September 30th at his home in Boston, having attained his eighty-second year.

Watson devoted the earlier part of his life to his education as well as to the teaching of mathematics and engineering at both Harvard College and the Massachusetts Institute of Technology. In 1873 he was appointed United States Commissioner to the Vienna Exposition. Five years later he was a member of the International Jury at the Paris Exposition, as well as Honorary President of the Paris Congress of Architects. He was also Vice-President of the International Congress of Hygiene which was held during the same year. During the years 1878, 1881, 1883 and 1889, he was Honorary President of the engineering section of the French Association for the Advancement of Science. In 1889 he became Vice-President of the International Congress of Construction. In 1893 he was Secretary of the World's Columbian Water Commerce Congress.

Many societies and clubs included Watson among their members, prominent among them being the French National Academy, the Cherbourg French Society of Civil Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Colonial Society of Massachusetts, and the Athletic, Round Table, Mathematical and Physical Clubs of Boston. He was a Fellow of the American Academy of Arts and Sciences and of the American Association for the Advancement of Science. Watson was well represented in the literary field with many mathematical books to his credit.

New Krupp Armor Plates

During the past year the Krupp works, at Essen, have perfected a new kind of armor plate that has a far greater power to resist the penetration of projectiles than any heretofore produced. But, although these plates are extremely valuable for the protection of ships of war, a wide application is anticipated for them in the building of safes.

Not only are the plates so extremely hard that they cannot be drilled, and consequently any necessary holes have to be cast in the plates when they are made, but they have a remarkable resistance to the flame of an oxy-acetylene lamp, and these features make a safe constructed of them practically burglar proof. The annexed table gives the result of experiments made on plates 4 cm (1.57 in.) thick.

Time of experiment in minutes.	Gases used (cu. ft.)		Hole burned (inches).		Material melted (cu. inch.)
	Oxygen.	Acetylene.	Diameter.	Depth.	
72	71.30	63.50	1.9685	1.378	2.44
128	76.25	53.00	1.5748	0.630	1.22
75	57.19	42.36	1.1811	0.669	0.62
99	63.50	42.36	1.5748	0.709	1.22
90	54.36	63.50	1.5748	0.709	1.22

It will be seen that in no case was the plate penetrated entirely. If a burglar should attempt to burn a hole in a safe large enough to admit his hand, say three inches in diameter, it would take him six hours to do the work, and would require 350 cubic feet of oxygen and about 320 feet of acetylene, which would take four tanks of 150 cubic feet each—not a very convenient outfit to carry on such expeditions.

Although heating will soften these plates so that they can be bent to some extent it does not lessen their hardness.

Electrical Exposition and Motor Show of 1915

HISTORY in the making in the form of the tremendous conflict raging throughout Europe—the wonderful machinery of modern warfare, enormous numbers of men engaged in battles lasting weeks, even months at a time, the transportation of munitions and food supplies for millions of soldiers, the destruction of cities, aerial fleets engaged in bombarding cities from the skies and in battling with each other—has quite overshadowed other events that have occurred during the past twelve months, more particularly events devoid of the dramatic.

So it is that the progress made in the field of electricity has gone unnoticed by the general public, although if the exhibits presented at the Electrical Exposition and Motor Show for 1915 are to be considered as a criterion, there have been several achievements of the highest order and numerous minor ones scored during the past twelve months.

It is safe to assume that the crowning feature of the Exposition was the exhibit of the American Telephone and Telegraph Company, in the form of an auditorium, wherein instructive lectures were delivered on the development of the telephone, as well as long distance transmission of conversation and music from San Francisco over the transcontinental telephone line. The auditorium provided seats for 164 persons, each seat being equipped with two telephone receivers which were connected at regular hours with San Francisco. The program included talking motion pictures on the birth of the telephone, including both the words and features of Thomas A. Watson, who under Dr. Bell's direction made the first telephone instrument; motion pictures of the constructional work on the transcontinental telephone line; telephonic conversation between San Francisco and New York, giving the news of the day and the happenings at the Panama-Pacific International Exposition; the transmission of music and, perhaps most striking of all, the roar of the Pacific Ocean beating against the rocks of the Cliff House, at Seal Rocks, near San Francisco, accompanied by motion pictures of that famous Californian resort. This exhibit was truly a fitting one for the greatest achievement in the electrical field this year, barring possibly the single exception of the radio telephone transmission of messages between Arlington, Va., and Pearl Harbor, Hawaii, accomplished by the engineers of the same company.

As in the past electrical shows, the keynote of the recent exposition was light; electric light of all kinds —mercury vapor lamps, carbon lamps, tungsten lamps and the more recent types of lamps filled with nitrogen and rare gases. Indeed, rapid progress has been made in the field of incandescent electric lamps, for it is not so many years ago that the first current-saving tungsten lamps were introduced. These were frail affairs; their filaments being shattered at the slightest provocation. Their field of application was limited to receptacles free from vibration and so placed as to permit the lamp to hang perpendicular. Shock absorbing devices for insertion between the receptacle and its support were even offered to more fully protect the fragile filaments. In marked contrast, the tungsten and gas filled lamps of to-day were exhibited under the most trying conditions, such as burning at different angles and placed in machines which subjected them to continuous jars, without affecting their efficacy.

Electrical cooking and heating devices naturally comprised an important feature of the Exposition. In general, however, there did not appear to be any radical departures, striking improvements or innovations in electrical devices of this nature, although there was much evidence of a steady effort on the part of all manufacturers to add various refinements to their products. In the main these devices represented the clever application of resistance units heated to any desired temperature by the passage of electric current.

The highest development of electric equipment for the home was presented in an exhibit known as "bachelor's model apartment," consisting of a large living room and a combination bathroom and dressing room. In the living room was a kitchenette measuring 10 feet long and 26 inches deep, in which were placed a washing machine, dish washer, irons, vacuum cleaner, ice cream freezer, small electric stove and oven, ozonator, electrical refrigerator, percolators and toasters. The kitchenette was cut off from the living room by curtains. The living room contained a grand piano with a player attachment, an electrically-operated phonograph, breakfast cart, tea table, fire place, dictagraph, electric fan, hand sewing machine driven by a detachable electric motor, clock, intercommunicating telephone service, an air washer and a large number of artistic lighting fixtures. The bathroom included a bath cabinet, massage couch covered with electric blanquets, dressing table equipped with all the small electrical appliances available at present, pier glass with portable lights, electric fan, clock, electric heater and electrically-illuminated medicine cabinet. By ap-

(Concluded on page 347)

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

A Universal "Monroe Doctrine"

To the Editor of the SCIENTIFIC AMERICAN:

I do not believe that future wars can be prevented by independent treaties so long as all nations prepare independently to resist the expected or probable invasion of their territory by some other nation.

The very fact of being better prepared than some other nation seems to be in some cases a sufficient reason for regarding such treaties as "scraps of paper."

I believe that after this war is over all future trouble can be averted and war forever banished.

Let United States, England, France, Russia, and, if possible, Japan and China enter into an international agreement, for a sort of international police regulation.

Let this international organization invite all other nations who care to, to join in the agreement. I think all South American republics and possibly some other nations would be glad to come in.

Let the organization then promulgate a sort of a world-wide "Monroe Doctrine," giving notice to every nation of the Earth that the invasion of the territory of any nation by the army or navy of any other nation will be considered an act unfriendly to, and that it will be promptly dealt with, by the international organization.

Let there be no restriction to the size of the army or navy that any nation may support, but, let the organization agree on the size of armament and men that each party to the agreement would keep always up to date and in reserve subject to instant call for international police duty.

A nation does not go to war unless the leaders think it can win.

Against such an organization there would be no possibility of winning, so there would be no war.

The amount of the allotment to each nation would be so small that if each nation did not care to provide more than the requirement, it would in many cases almost amount to a disarmament.

The immense sums now spent on coast defense and border armament would be saved and national boundaries would become like the present boundary between United States and Canada, where for thousands of miles there is not a fort or an armed man on guard.

A. I. LOOP.

North East, Pa.

The Unshod Horse

To the Editor of the SCIENTIFIC AMERICAN:

It seems to me that the ideal way of shoeing a horse would be the paradoxical one of not shoeing him.

I mean that a barefooted horse till he breaks the edges of his hoofs, and makes his soles sore from friction, slips less and has a better foothold than when shod in any way yet invented.

I have ridden a horse, deer hunting, who had never been shod for many years and his feet always remained perfect in shape, without any broken edges or frog or sole unduly worn, but then I only rode him at a walk and on soft ground, except for a short trot on the way out and home on a sand road.

Now, could not some way be found for painting with some chemical the sole, and especially the edges of the hoof, so as to toughen it, without losing it's elasticity, so that roads should not wear down an unshod foot?

It is this springiness, opening and shutting of the hoof at the quarters, which takes the jar off a horse's foot, and it is the foot being bound by an iron shoe which does not let the foot open on pressure being put on it and which also keeps the frog of the foot off the ground, instead of the frog acting as a cushion to take off the jar, which is the cause of all the laminitis, ring bone, foundering, &c., of shod horses.

Rubber pads, also, by keeping the air off the soles and preventing proper cleaning, are the cause of thrush and foot diseases.

Can any of your readers suggest any fluid which could be brushed daily on the sole and edge of the hoof to toughen it?

WALTER WINANS.

London, England, Aug. 25th, 1915.

A Case of Mistaken Identity?

To the Editor of the SCIENTIFIC AMERICAN:

Your military writer, Capt. Hanna, who has been discussing the war so interestingly from week to week, has also fallen into the error made by many newspaper strategists in regard to the campaign in Northern Russia. It was generally thought that the German forces were surrounding the Russians and that the latter with a great display of military capacity, had succeeded in escaping. This assumption is false, however, as the Russians at no time were surrounded, or even threatened with having their retreat cut off.

The error arose from the use of insufficient maps, through which the town of Vileika was incorrectly located. There are two towns of this name. One lies about 40 miles northeast of the railway junction of Molodetchno and 20 miles from any railroad. This is not the town in question, and it has never been in German hands. The assumption that von Hindenburg had taken it is what has led so many astray. The Vileika which the Germans mentioned in their reports as having been taken lies about 15 miles east of Vilna, at a point where the railway branches, one line running to Dvinsk, the other to Molodetchno and Minsk.

It is, therefore, incorrect to say that the attempt to surround the Russian forces in that region was a failure and that they escaped from the trap. The trap really did not exist.

E. S. PRIETH.

Newark, N. J.

Measuring the Altitude of a Kite

To the Editor of the SCIENTIFIC AMERICAN:

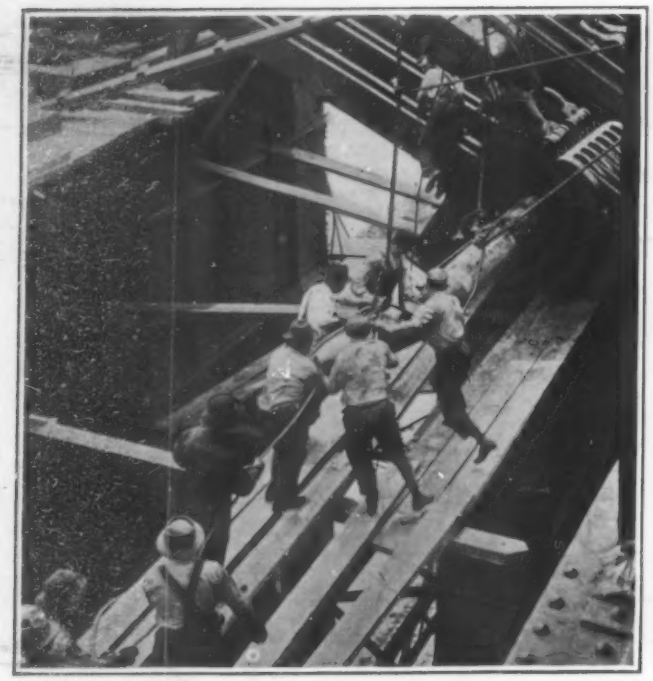
Referring to an article in the SCIENTIFIC AMERICAN, of September 18th, entitled "Measuring the Altitude of a Kite," permit me to correct what I think is probably a misprint. When I was a boy I flew many kites and I never saw the string stretched out in a straight line as the article assumes. At a certain point the string curves more or less upward, and is much longer than the hypotenuse of a triangle having the horizontal distance of the flyer of the kite to a point directly underneath it, and its vertical heighth as the other two sides. A practical way to find the height of a kite on a level plain would be to send an assistant to a point underneath the kite and measure the distance from the flyer to said point as a base line. Now suppose the base line was found to be 2,400 feet and the angle of elevation of the kite 16 deg., then sine 16 deg. is to the height of the kite as cos 16 deg. is to 2,400. Sine 16 deg. is .27564, cos 16 deg. is .96126, and the height of the kite is 688.196+ feet. I think this is probably the method intended, as Prof. Hiett would not overlook the fallacy that I pointed out.

E. A. RICHON.

San Jose, Cal.

The Current Supplement

ALMOST interesting article in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT (No. 2076, for October 16th, 1915) describes a very remarkable mining operation where the old shafts and tunnels of a worked out silver mine were abandoned, and a whole mountain is being dug away by monster steam shovels, working on a series of terraces. It is a revolution in mining methods, and the system of working is illustrated by a series of striking photographs. A new method of treating gaseous gangrene, the discovery of an American surgeon now working in the war hospitals in France, has attracted considerable attention recently. The complete description of the new procedure, by its originator, appears in this issue. High temperatures are being demanded more and more frequently in both scientific research and technical processes, and there is a valuable survey of the question. "An Indiana Desert" tells about a most curious little tract of territory that is of interest both to the scientist and the lay reader, and it is fully illustrated by a series of excellent photographs. The development of the aeroplane, and the demands being made upon it in the military operations abroad, have emphasized the fact that greater power must be furnished. There is an excellent discussion of aeroplane engines and the principles of their construction. For years efforts have been made, not only to effect the transmission of messages by the ordinary telegraph more rapidly, but to devise some means by which the messages might be automatically received and delivered in printed form. Several systems are now in practical operation, for the transmission of formation, and one of these is described in the current issue of the Supplement, and the instruments employed are illustrated. Heretofore the X-ray tube has been considered to be of use only to the surgeon, and for medical work. Now this instrument has been so improved that it is being found of great value for many technical purposes, as for ascertaining the internal structure and conditions of metals and other materials. A description is given of one of these engineering applications, accompanied by a diagram of the apparatus used and the results obtained. Many valuable articles have been published on atoms, molecules and electrons, but considerable special knowledge is necessary to their proper understanding. All of these matters are made clear in a paper written in simple language for the general reader, and a fund of information is given that will be widely welcomed. The Natural History of the Whale Shark is concluded, and there is the usual interesting assortment of short articles of general interest.



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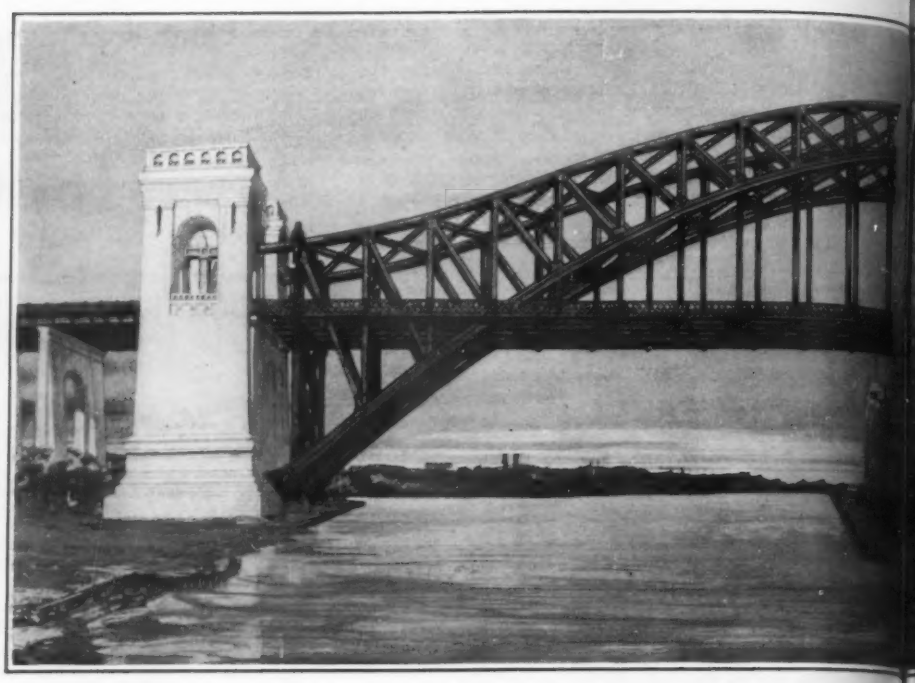
Driving a pin at the top of the erection tower



The Hell Gate arch would span four [illegible] and

The Largest Arch Bridge in the World

Direct Rail Connection Between New England and the South and West

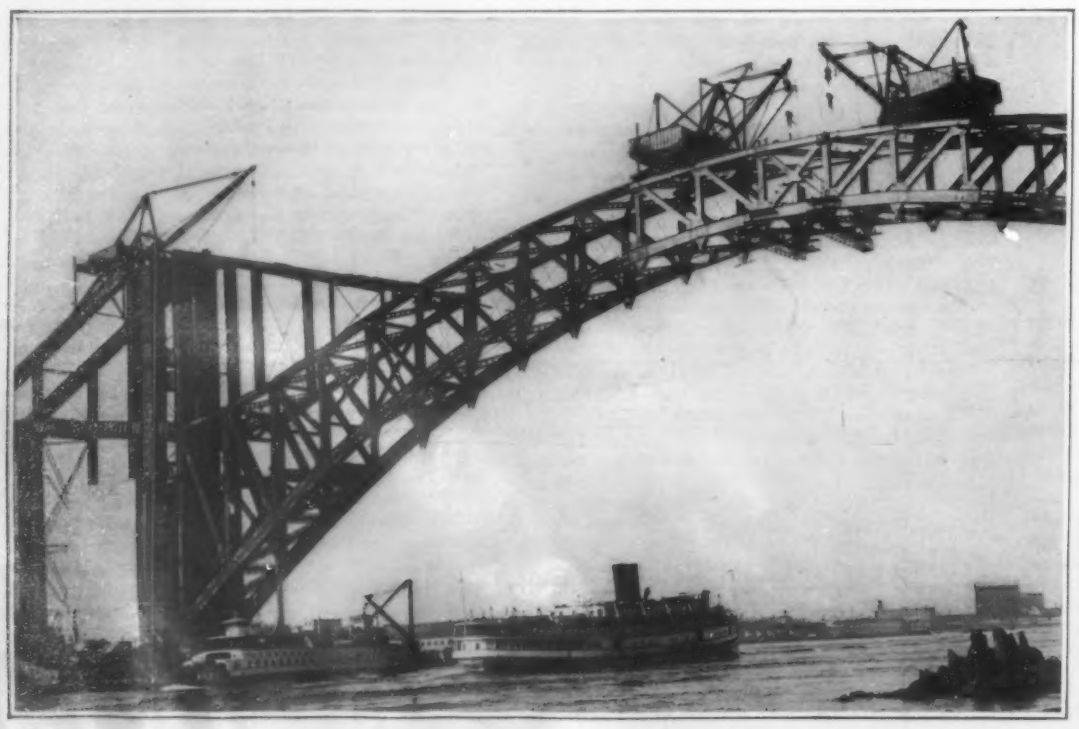
AN important feature of the costly improvement carried out by the Pennsylvania Railroad in and around New York, including the Pennsylvania Terminal in Manhattan, and the North River and East River tunnels, is the building of the connecting railway for uniting the systems of the Pennsylvania Railroad and the New York, New Haven and Hartford Road. This connection has been made by means of a crossing of the East River, the most important feature of which is an arch bridge, the largest in the world, of about 1,000 feet span. The steel arch forms the most important feature of a steel viaduct, itself the largest of its type in the world, the whole length of the structure, from Long Island to the Bronx being about 17,000 feet or considerably over 3 miles. With a wide, sweeping curve, the viaduct passes over Hell Gate, Ward's Island, Little Hell Gate, Randall's Island, and Bronx Kill. It is not only the longest, but considerably the heaviest steel bridge in existence, over 80,000 tons of steel having been required for its construction. With its early completion, the City of New York will find itself in possession of an all-rail route between New England and the south and west. Through trains from Boston may then run to New York, Philadelphia, Baltimore and Washington, Palm Beach, New Orleans, Chicago, St. Louis or any other southern or western city, without leaving the rails. Hitherto, cars for such through trains have been ferried around from Long Island and the Bronx to Jersey City.

The imposing steel arch, whose bottom chords have recently been closed, has a clear span between abutments of about 1,000 feet, or 977½ feet between centers of hinges made up of 23 panels measuring 42½ feet between centers. The depth of the truss at the ends is 140 feet; at the center, 40 feet; at the quarters 66 feet. The reverse curve, which will be noticed in the upper member of the arch at each end, is explained by the necessity of raising the top member of the portal to a sufficient height above the tracks to allow head room for the trains. At the quarters, the height has been purposely made such that no increase in the sections of the arch member is required to meet the bending strain due to one-sided loading.

The rise of the arch is 220 feet, the maximum depth of the truss at each end is 140 feet and the total width over the floor system is 93 feet. The weight and dimensions of the members of the arch are considerably the largest on record. This is due to the great length of the span, for an arch bridge, and to the fact that the structure will carry four railroad tracks, and a solid ballasted floor on concrete deck. The size of the arch members is shown by the dimensions of the lower chord, which is rectangular and about 7 feet wide throughout, with a depth of 7½ feet at the crown to 10½ feet at the abutment. The weight of the bridge alone, independent of its live load, is enormous, as shown by the fact that it averages 26 tons to the linear foot throughout the bridge.

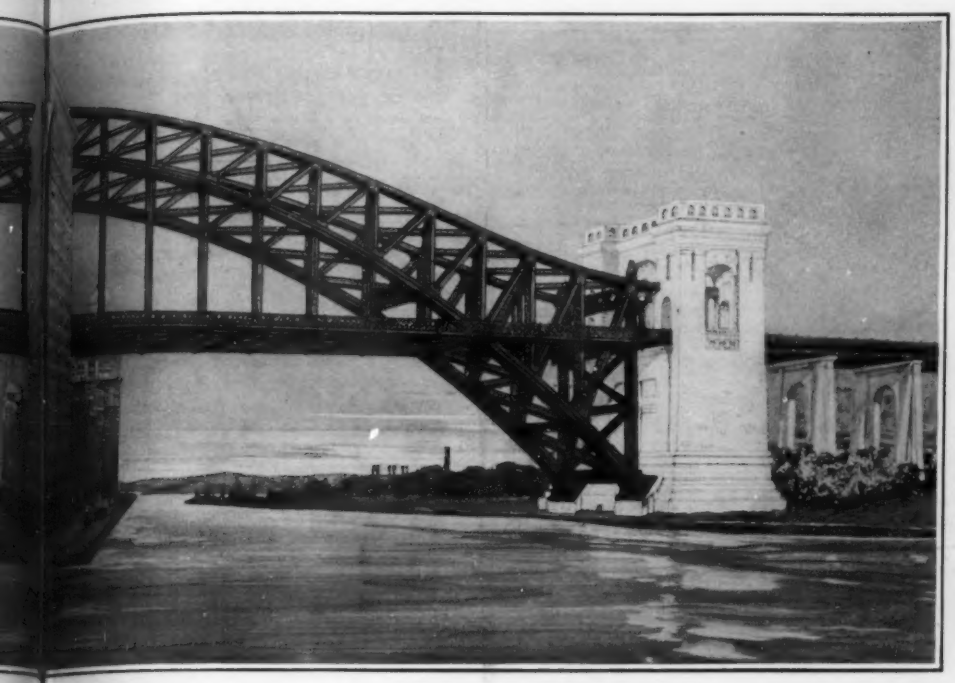
It may be mentioned here that, although this bridge is on the average much heavier per linear foot than the cantilevers of the Quebec Bridge, which fell, and the compression members are much larger and are subject to greater loads, the latter have been constructed on a system which precludes the possibility of any such crumpling up and fall as occurred in the Quebec Bridge. The compression members of the chord

Gustav Lindenthal, [illegible] Hell Ga

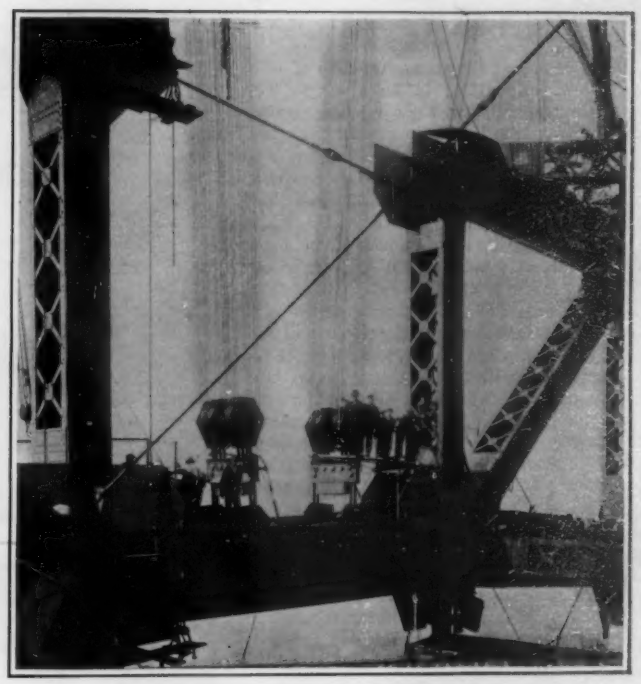


One half of the arch as seen from the Long Island side

General view, showing [illegible] of arc



...n four tracks and overtop the "Flatiron" building



Eighty-ton connecting bottom chord section lifted into place

...l, de... Hell Gate Arch Bridge

are of box section and, as stated, are of unusual size. The Quebec chords failed for several reasons, chief of which was that the steel diaphragms of which they were built up were held in line by pitifully weak angles and riveting. In the case of the Hell Gate bridge, the cross-section of the chord is that of a true box with heavy, continuous steel cover plates taking the place of the absurdly light latticing which was the main cause of the Quebec Bridge failure; also the chords are stiffened by longitudinal and transverse internal diaphragms. Hence their failure is the very last thing to be considered in this bridge.

It should be recorded here that this vast bridge together with the costly improvements effected by building the tunnels and the Manhattan terminal were due to the initiative of that great Engineer-President, the late Alexander J. Cassatt. The bridge was designed and has been carried through by Gustav Lindenthal, who is known, both here and in Europe, as one of the greatest authorities on long-span bridges.

The arch, as is clearly shown in the illustration, was built out by overhang in two separate halves, which were carried out simultaneously, panel by panel, from the base of each main pier, the steel work being tied back to massive temporary anchorages. The anchorages consist of compression and tension members built up of the steel plate girders which will subsequently be used to support the floor system of the viaduct.

In the construction and erection of such a great engineering work as this, complexities are certain to arise; and the Hell Gate bridge has had more than its share. Chief among these was the discovery, during the excavation for the foundations of the main towers which take the thrust of the arch, that the solid rock, at a depth of over 100 feet below the surface of the water, was traversed by a deep and wide fissure. The foundation measures 125 feet by 140 feet and this wide gap in the rock ran clear across the site. The fissure was at too great a depth to be reached by pneumatic work, and Lindenthal solved the problem by the bold scheme of bridging the gap with a massive concrete arch. When this had been done, the work proceeded satisfactorily. The direct thrust of the bridge trusses is taken by two solid walls of reinforced concrete. Between and outside of these walls there are rows of cylindrical caissons 18 feet in diameter. The whole is capped by a slab of concrete 18 feet thick. The main towers superimposed on the foundation rise to a height of 260 feet. They are able to take the enormous diagonal thrust of the arch amounting on each side to 15,000 tons with a wide margin of stability.

To return to the erection of the steel work. This was done by what is known as the overhang method. The arch was built out from either side, panel by panel, until the two parts met at the center. As the work proceeded, it was held in place by means of two huge frameworks of a general A-shape, with one leg of the "A" buried in the ground with its foot against the base of the tower, and the other leg extending above the tower. From the end of the upper leg massive ties (built up of members which will ultimately be incorporated in the bridge) were carried down to connect with the upper chord of the bridge. The first connection was made at the end of the top chord, and another tie was run down to the sixth panel point of the top chord. The weight of the individual bridge members that were handled during this operation was enormous, the largest single chord member, viz., that in the first panel at the abutment, weighing 185 tons.

The closing of the arch was effected by the simple operation of lifting, by means of the traveling cranes on the two ends of the arch, the final sections of the bottom chord, each weighing 80 tons, from a barge on the river below, and bolting them in place. One of our illustrations shows this member held in position ready for bolting up. This was done by lowering the two cantilever arms, by means of powerful jacks located on top of the erection towers over the piers, until they came to firm bearing at the center, the structure thus being converted into self-supporting three-hinged arch trusses. From now on, the work on the arch will consist of attaching,

(*Concluded on page 348*)

...wing ...rd of arch connected up

This view shows the temporary tower, backstays, etc., used to hold the arch in place during erection

Ancient Relics Unearthed in War Trenches

IT is one of the many surprises of this world-war, that, in spite of an undoubted paralysing influence on peaceful pursuits, it is bound occasionally to stimulate actual scientific research, quite unconnected with strategic considerations. One of the branches of pure science that are apt to be most benefited in this way, is archæology, and a short account of some results achieved in this connection will, it seems, be of interest.

We are indebted to Prof. Schahhardt, of the Berlin Archæological Museum, for some particulars on recent finds made in connection with trench digging, as well as in clearing the large areas of waste ground now being opened up for agriculture.

A German officer, Count Spee, while on a home leave, recently brought to Berlin a series of clay fragments, some of which are of Merovingian origin; he also gave an account of his own and some colleagues' researches on sarcophagi and a Roman castrum believed to have played a part in Cæsar's Gallic War. Another report received from the region between Arras and Lille is relative to what seems to be prehistoric galleries in the soft lime, possibly searching tunnels used in flint extraction, of which there are many in Belgium and the South of England.

A most valuable addition to the Nassau collections was found in the contents of 31 La Tène tombs discovered by Captain Pehlemann and a young pioneer, Hans Niggemann who, before the outbreak of the war, had, for some years, been studying archæology. A bronze ring and a fragment of a human skull having been found in a trench, in the Soissons district, some dark spots were noted at the trench edges which, on further examination, proved to be tombs. Some of these having been laid bare by digging side trenches, the bodies of the dead were found to be arranged on a gravel bed, encompassed by round timbers; they were adorned with bronze rings round the neck and arms and fitted out with beautiful black polished pottery. Only in one grave were there found any weapons, viz., three iron spear points. Of the skeletons themselves all that could be saved was preserved, in the first place 10 skulls, mostly fine dolycocephalic heads. These finds belong to the period of greatest prosperity of Celtic culture, during the 5th and 4th centuries before our era, that is, to the culture of the people which then, under Brennas, undertook its famous war of conquest against Rome. This had so far been mainly unearthed in the Marne district and is therefore known as "Marne culture." The objects brought to light by the German soldier-archæologists constitute a most important scientific achievement in the midst of war and a valuable addition to the scanty material so far available from that interesting period.

The eastern front has likewise yielded an interesting find, a cemetery from the time of the Roman emperors, with meander pottery and a Hadrian coin having been found near Mlawa. The chief interest of this is the fact that it proves the Teuton tribes, at that time, viz., in the second century of our era, to have extended as far east as that.

The war work in the interior of the country, finally, has likewise brought to light many interesting things, especially in erecting new buildings, clearing waste ground, and collecting old metal. Fragments of Slavonic pottery have thus been unearthed at Wilkersdorf, near Königsberg, together with the rests of a leaden collar of the type used at the bronze period, but with ornaments such as are found on objects belonging to the Viking period.

Extensive excavations are now being made at Minden, where French prisoners, engaged in clearing a large tract of heath, found pre-historic tumuli each 10 meters in diameter.

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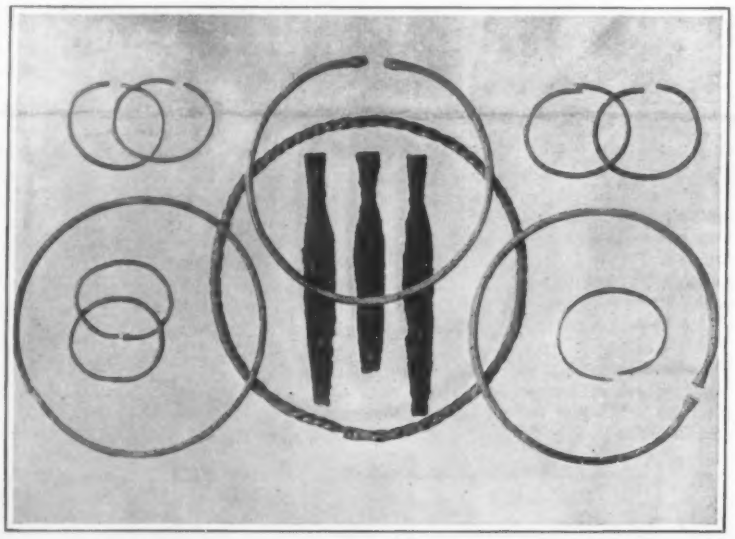
The Wyoming's raceboat crew keeping in condition. There is no room for rowing machines, so the men rig up simple exercising apparatus

Devices for the convenient transport of the wounded in narrow, crooked trenches. The hammock has bands that prevent it from sagging, and an adjustable board to support the injured member



Ornamental necklaces and arm rings of bronze found by German soldiers when digging trenches near Soissons. Three iron spear heads were discovered in the same vicinity. These relics are of Celtic origin

Beautiful black polished pottery, representing the most advanced period of Celtic culture of the 4th and 5th centuries before the present one, that were discovered in an ancient cemetery by German troops when digging trenches near Soissons, France

Improvised Rowing Machine

THE cutter races in our navy are very keenly contested. Each ship has its crew of picked men who train for the contest with all the earnestness and enthusiasm of a college team, realizing that the honor of the ship rests upon their efforts. Of course, while the ship is under way and when the weather is unfavorable, actual practice in the boat is out of the question, but the competition is such that the crew must keep in condition if it would win. A college team would be supplied with rowing machines. This luxury is denied to the young tars of our navy, but being of a resourceful make-up they improvise apparatus which serves the same purpose even if it be not so efficient.

The accompanying photograph illustrates the "home-made" rowing machine used aboard the U. S. S. "Wyoming." It consists of rope and tackle, with a handle at one end of the rope and, at the other, a weight made up of a set of iron plates. The coxswain, watch in hand, may be seen calling the stroke.

Stretcher Hammock and Stretcher Chair

Invented by the Comtesse de Chaumont Quitry

By Neil Truslow

ENTERING a trench after a battle one is impressed by the great difficulty in caring for the wounded. Twelve hours after a battle, you often find men who have only had a hasty first dressing. This accounts for the number of gangrene cases at the beginning of the war, when 36 and even 48 hours were required to get the wounded to a base hospital.

Trench warfare has made it most difficult to transport the wounded; narrow winding "boyaux" or connecting trenches, 7 to 8 feet deep, with earthen walls, kept in place by fascines of woven willows, and with as many twists and angles and hairpin turns as the maze of Hampton Courts, do not facilitate this transportation. It takes two men, three and often four hours to get a "blessed" (wounded) to the ambulance base; 10 kilometers is not an uncommon distance to carry him, and owing to the many sharp turns, the old military stretcher was found absolutely useless. At first, the wounded were carried in blankets, sacks or on a comrade's back, anyway to get him where he can be cared for. So carelessly were they handled that often by the time he arrived at the hospital, he was dead.

Comtesse de Chaumont-Quitry, a lady of rare ingenuity and ability, who knows the soldier and his sufferings in the trenches, has produced many things for his comfort and help. Possibly the most interesting is the stretcher hammock and stretcher chair for the transportation of the wounded through the narrow winding passage in the trenches. Both are specially adapted for this work.

The stretcher hammock consists of a canvas hammock attached to a single pole 7½ feet long. In the middle of the pole a canvas sling passes around the hammock supporting the weight of the body. A longitudinal pocket in the centre of the hammock contains a board 3½ feet long and 8 inches wide, which may slide forward and backward to the place of the wound or fracture, and that point of the limb or body is securely laced in position, relieving it entirely from movement or vibration.

I recently spoke to an officer who had just come into the ambulance base in one of these hammocks. A high explosive shell had fractured his pelvis and both bones of the upper leg were broken. He had travelled 18 kilometers, taking nearly 5 hours, yet with enthusiasm claimed he had suffered but little.

For those whose wounds are less serious, the stretcher chair is used. It is far more easily handled and constructed in a most simple manner. It consists of two short sticks 4 feet long with handles at each end, over which is stretched a piece

(*Concluded on page* 348.)

Completion of Arrowrock Dam

The Highest Dam in the World

By M. F. Cunningham

ARROWROCK dam, near Boise, Idaho, is completed and has been in service during the irrigation season of 1915. It was dedicated with elaborate ceremonies on October 4th and 5th, bringing to a close a great engineering undertaking.

In the reservoir above the dam, water is to be stored for the irrigation of 234,000 acres of fine land adjacent to Boise, Nampa, Caldwell, and a number of smaller towns within the limits of the Boise Irrigation Project of the United States Reclamation Service.

Arrowrock dam is the highest in the world, 348.5 feet from the low point in the foundation to the top of the parapet. It is 1,100 feet long on top, contains 585,200 cubic yards of concrete, and its crest carries a roadway 16 feet wide. The dam has a gravity section and is built on a curve of 662 feet radius. The spillway intended to carry off the surplus water when the reservoir is full consists of a run 400 feet long and a concrete-lined discharge trench 900 feet long with a capacity of 40,000 second-feet. In the run and trench lining 25,400 cubic yards of concrete was used, all of which was reinforced.

The spillway run carries a movable crest of unique design which permits the storage of water six feet higher than the fixed crest. This drops automatically in case of flood, so as to give the full capacity of the spillway when needed. It rises automatically again when the flood has passed.

Above the dam in the basin of the Boise river there is 3,000,000,000 feet of merchantable timber, while the mills are 14 miles below. A device is constructed at one end of the dam to hoist logs of any size or length from the reservoir, carry them over the top and shoot them into the river below. It has a capacity of 1,000,000 feet a day during the time of the year when the water in the reservoir is within 45 feet or less of the top of the dam. A cable lift picks the logs out of the reservoir and swings them to a platform on top. From here they are carried by a bull chain through a concrete chute 650 feet long and shot down to the river on an incline of 62½ per cent.

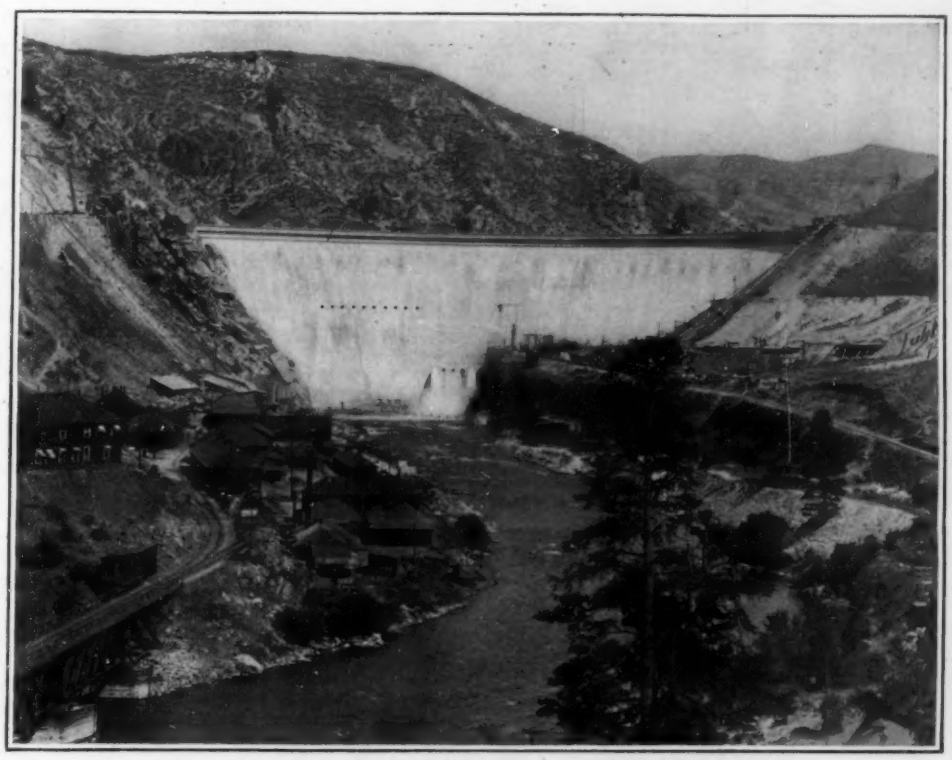
Preliminary to the construction of the dam it was necessary to build a standard gauge railroad 17 miles long from Barber, the nearest point on the Oregon Short Line, to Arrowrock. This railroad has been operated for four years by the Federal Government. In that time it has carried 80,000 passengers and approximately 14,000,000 tons of freight.

Twelve miles down stream from Arrowrock a 3,000-horse-power hydro-electric plant was established by the Government to furnish energy for the operation of the construction camp. This has furnished all the electric power needed for construction, and in addition a considerable surplus that was sold to local companies. The total output of this plant since May, 1915, has been approximately 20,000,000 kw. hours.

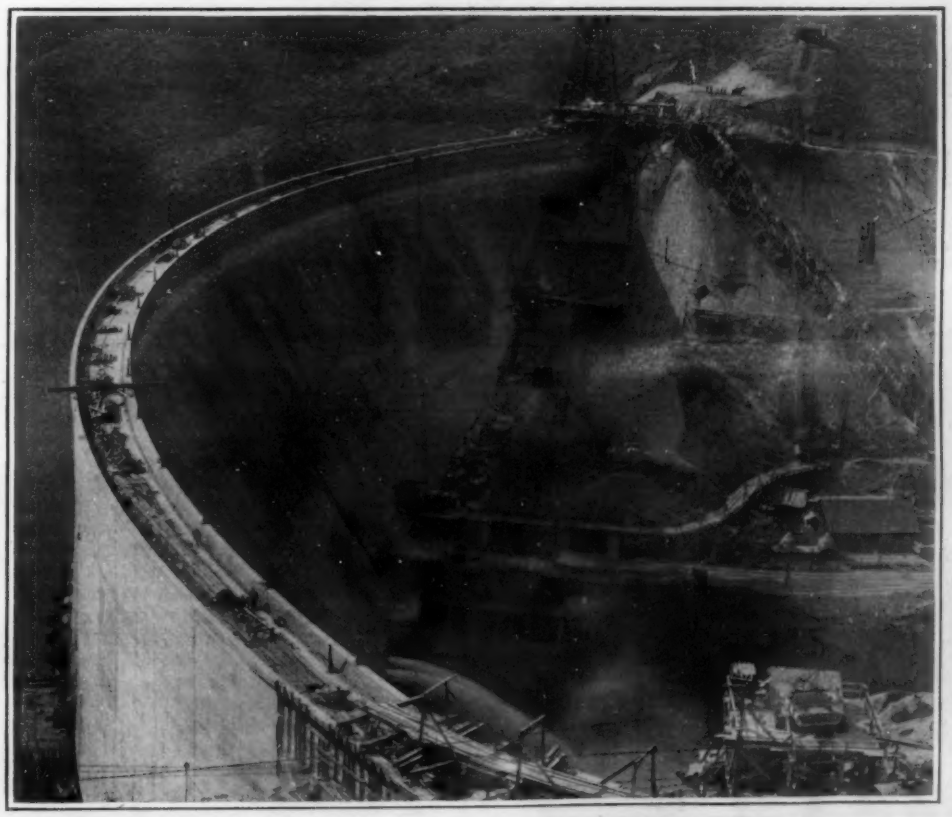
The excavation for the dam extended 91.5 feet below the bed of the river through volcanic rock to the solid granite. A diversion tunnel 500 feet long with a cross section 30 x 25 feet carried the river around the work through a cliff at the side until the construction was far enough advanced to permit the storage of water.

Outlets in the dam, twenty in number, each 4 feet and 4 inches in diameter, will release the stored water as it is needed for irrigation. These are controlled by 58-inch balanced needle valves on the up-stream face of the dam. They are in two sets of ten each, the upper set being located 150 feet above the bed of the river. Five sluicing outlets, each controlled by a 5 x 5 foot sliding gate, are installed at river bed level. All the outlets are operated from control chambers inside the dam.

A system of inspection galleries, of which the control chambers are a part, give access to the dam at several elevations. The lowest of these is 230 feet below the normal high water surface in the reservoir. The capacity of the reservoir is 244,300 acre-feet, or about 79,600,000,000 gallons. This reservoir is 18 miles long and extends up both branches of the river. When needed for irrigation the water is carried down 12 miles in the channel of the river to a low diversion dam and from there it is taken out over the land through a network of canals and laterals. By this irrigation system 234,000 acres of barren sagebrush desert is to be converted into gardens, orchards and farms.



View of the Arrowrock dam, taken from a point below it on the Boise river



Arrowrock dam, looking down upon the parapet road and into the basin

Some of the quantities involved in the construction of Arrowrock dam and the spillway are as follows:

Excavation, cubic yards	683,000
Concrete, cubic yards	610,600
Reinforcing Steel, pounds	1,350,000
Structural Steel, tons	1,800

The United States Reclamation Service has invested $12,000,000 in this project and this amount is to be returned to the Government by the farmers in twenty annual payments for water rights. The dam alone cost $5,500,000. It is completed more than a year in advance of the time fixed at the beginning of the work, five years ago, and at a cost $2,000,000 under the estimate. The water stored this year saved the crops on 100,000 acres.

The two accompanying illustrations were taken while the constructional work was still in progress. The view looking down into the basin is of particular interest because it clearly shows the wide road that crowns the parapet.

All this work was done under the direction of F. E. Weymouth, supervising engineer for the U. S. Reclamation Service, with Charles H. Paul, construction engineer in direct charge, and James Munn, superintendent of construction.

Flour Substitutes

The U. S. Bureau of Chemistry is now testing a number of so-called "flour substitutes." These are not intended to replace wheat flour, but to be used in combination with it in making bread. The substitutes thus far examined include flours made of chestnuts, bananas, peanuts, soy beans, peas, corn, barley, oats, rye, etc. Altogether about thirty substitutes have been found to give satisfactory results when not more than 25 per cent of the substitute is used with 75 per cent of wheat flour in bread-making. Bread made of 12 parts of boiled potato to 9 of ordinary flour is said to be satisfactory.

The Motor-driven Commercial Vehicle

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any questions relating to mechanical features, operation and management of commercial motor vehicles

Interesting Forms of Farm Truck-Tractors

By Victor W. Page, M.S.A.E.

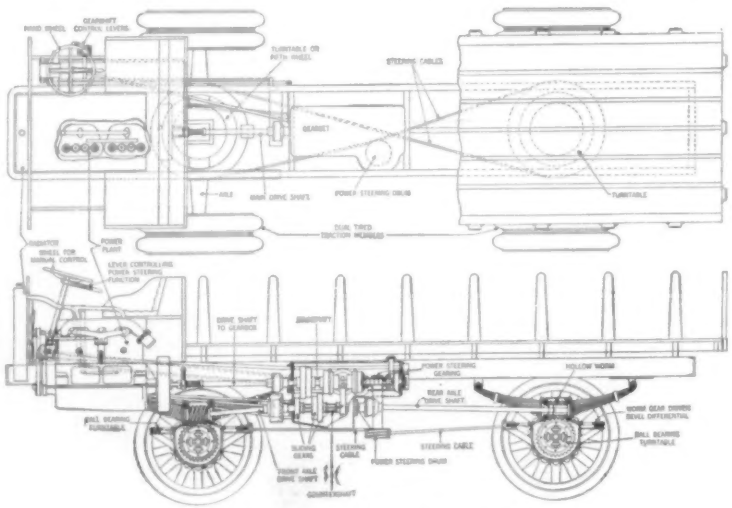
WHILE the heavy gas tractor has demonstrated its worth in a remarkable manner, there are several disadvantages of this type that militate against its more general adoption. It is a single purpose machine and, while it does well the work for which it is intended, it is not sufficiently versatile to replace the horse generally. Eminently suited to the heavy work in the field, it is incapable of performing road work efficiently. Most tractors built in the past have been heavy, cumbersome and slow. These qualities were inherent in a design intended only for supplying tractive effort. Only farmers having a large acreage could use them profitably as they were idle nearly nine months each year.

Realizing that a practical motor vehicle for farm use must be capable of doing any work animal power can do, and that it must be of such form that it can be employed the entire year, a number of manufacturers have evolved a type of combination vehicle suitable for work on the road or in the field. These are capable of drawing ploughs, harrows and other tools for tillage, have sufficient power for hauling harvesting machinery, are provided with a pulley for belt power and are capable of both carrying and drawing a load on the highway.

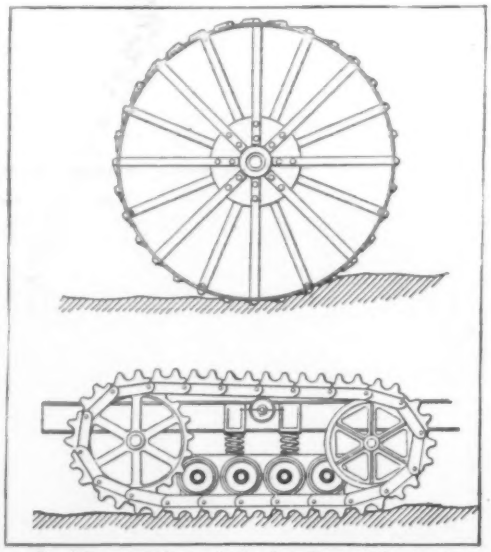
Two typical designs that have been offered are outlined in the accompanying illustrations. The caterpillar tread has been applied to a vehicle intended for either field or road and possesses all the advantages of the "track laying" tractors. It automatically lays and travels on a smooth, practically level steel track which is strong and reasonably flexible. This makes the vehicle practical in ploughed fields, soft delta lands, country and wood lot roads, in gravel pits and on soft snow.

These advantages are secured by means of the distribution of weight over a larger area of ground than can be obtained with the conventional wheel or even the "pedrail" wheel. The track-laying principle means that an increased area of contact between the traction members and the ground produces a more effective pull which shows in increased draw bar horsepower. A comparison which has been worked out graphically to show the advantage of the caterpillar tread on tractors applies just as well when it is used on the tractor-truck. In the example illustrated, the wheel bears against the ground with a pressure varying from 40 to 90 pounds per square inch, the other construction distributes the load over a much larger area and the pressure is but 5 or 6 pounds per square inch. The caterpillar tread is said to be practical where even horses cannot venture. This form of traction member is only suited for slow speed vehicles, whereas the wheel can be used on the highest speed automobiles. As any vehicle intended for heavy duty work can only be operated efficiently at low speeds, this cannot be considered a disadvantage that would make the caterpillar tread unsuited for farm work.

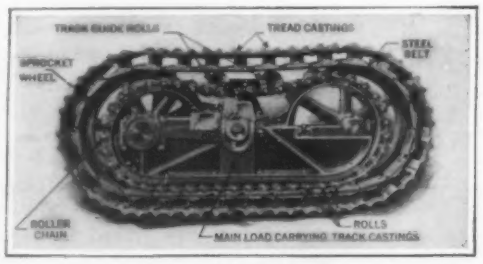
The construction of this form of traction member is clearly shown in the accompanying engraving. The track shoes, which come in contact with the ground and take the place of a tire on the ordinary wheel are drop forged from plough steel, or are steel castings. The track rails are heavy steel or semi-steel castings. The outer tread link is made in one piece. The links are bolted to two flexible steel belts which pass around the sprockets to form the tread member. The belts are of vanadium steel and are 4½ inches wide. The outer or tread chains are 12 inches wide and have 5 square feet of bearing surface, or 10 square feet under each machine. The rolls used in the roller chains that separate the tread from the track and on which the tread rolls, are 3 inches in diameter, made of high grade tool steel and tempered. They form, in effect, a large roller bearing. The pins shown in the rolls are used simply to keep the rolls separated and do not carry any of the load due to the weight of the machine. These pins are carried on narrow steel belts in the same manner as the outer chain. The tread members oscillate on a supporting shaft and are independent of each other. This permits them to adapt themselves to inequalities in the road. Roller chains are 6 inches above the ground and mud will not clog the wheel.



Plan and side views of a four-wheel drive truck



Graphic comparison of wheel and caterpillar tread



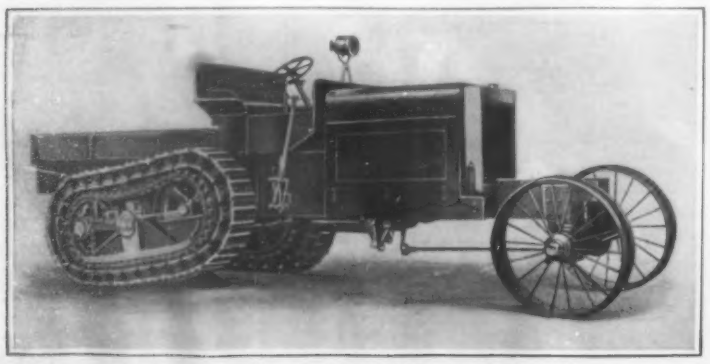
Construction of the caterpillar tread

Another interesting design is the four-wheel drive and steer tractor-truck. The wheels are driven by worm gearing of special form, both axles being alike. The power from the gasoline auto-type four-cylinder engine is transmitted to a special gear box from which drive shafts extend to the front and rear axle drive gears. The wheels in this design are not movable in respect to the axles for steering, but the entire axle swings around on a ball bearing turntable or fifth wheel arrangement. Steering is effected by a hand wheel when road conditions are good, but if the wheels become mired, a power steering apparatus is provided. This attachment is very ingenious and positive in action and its mode of operation may be readily understood by referring to the sectional drawing herewith. The axles are swung around the center support by crossed steel cables, one of these being coiled around the power steering drum. This drum is driven by worm gearing in the change speed gearbox, the direction of gear rotation being determined by a pair of clutches shifted by a lever under the hand wheel. If the gearing is engaged by the forward drive clutch the axles are turned in one direction, if by the reverse clutch, they are moved to the other position. When the power steering lever is in neutral, the axles are subject only to hand wheel control. Attention is directed to the distinctive form of hollow driving worm which also acts as a housing and driven member of the universal or slip joint necessary at that point to permit the axle to swing without binding the propeller shaft.

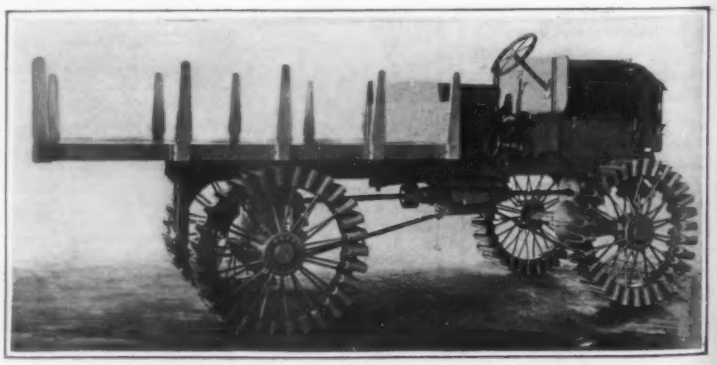
The form of wheel shown in the photograph has been devised with a view of having a traction member adapted either to a soft or hard road surface without any mechanical changes. When wheeled vehicles are intended to be used in the field, grouters are usually fitted to the wheels to increase traction. These must be taken off to prevent injury to hard roads. The wheels illustrated are made in a specially corrugated tread form and, while they offer ample surface for hard roads, they dig into soft ground and provide the necessary traction when hauling ploughs and other farm machinery.

A Correction

In our recent brief biographies of the members of the Naval Board of Inventions it was stated that Andrew L. Riker resides in Detroit. This was an error, as Mr. Riker lives in Bridgeport, Conn., where the Locomobile Company of America, of which he is vice-president and chief engineer, is located.



How the caterpillar tread is applied to the truck tractor



Farmers' truck tractor with peculiar wheel tread

Motor Truck Notes and Queries

F. R. M. writes: 1. The driving chains on a two-ton truck I am driving seem to wear unduly fast and need frequent replacement. They whip and snap when the truck is in use, and no matter how they are adjusted they give trouble. The sprockets are the original ones that were on the car when purchased and do not seem to be very badly worn. 2. What is a double reduction axle and what are its advantages?

A. We are not surprised at the trouble you are having with your chain driving system, and you can expect trouble until you replace the worn sprockets, both on the jackshafts and wheels, with new ones. When a new chain of any form is run on worn sprockets it will soon wear out because the chain pitch tries to conform to the sprocket pitch which has been altered by wear. In many cases the sprocket teeth are worn hook shape; this produces the whip and snap you refer to, as will chains that are adjusted either too tightly or too loose. We suggest replacing both chains and the four sprockets, and after this is done, making sure that the chains are kept clean, properly lubricated and well adjusted. When pulling, a chain should be taut at the top and have enough slack below the sprocket so that it bows out and can be lifted a small amount by the hand. When the power is off there may be a slight sag in chain both above and below the sprocket.

2. A double reduction axle is a form having two speed reductions between the main driven shaft and the wheels. One method is to obtain a primary reduction between a bevel drive pinion on the main shaft and a bevel gear on a countershaft mounted either above or ahead of the differential gear. A small spur pinion on the countershaft drives a large spur gear attached to the differential. This provides a secondary reduction. The drive from the differential gear to the wheels is by live axle shafts just as in any live axle. Another method is to attach a bevel gear driven axle member to a fixed or "dead" axle and take the secondary drive from small spur pinions mounted on the live axle shafts which mesh with internal gears attached to the wheels. The primary reduction is obtained through the bevel gears, the secondary reduction through the spur gearing. The advantage is that they make the shaft drive possible on the heavier vehicles formerly driven by chains and all gearing is enclosed and runs in lubricant. The form having the internal gear driven wheels is the most popular, as it has more ground clearance than either the worm drive axle or the double reduction form, in which all gearing is carried in the differential casing.

E. R. N. writes: We are operating a five-ton truck in hauling crushed stone short distances and are operating our truck constantly in the stone dust laden air. Recently, in taking down our carburetor for cleaning, we found it coated inside with this dust. What is the possibility of this dust getting into the engine and what harm can it do? Is there any way of preventing entrance of this dust?

A. In view of the statement that the interior of your carburetor is coated with stone dust, it is apparent that considerable quantities have found their way into the cylinders. While the greater portion of the dust inspired is undoubtedly expelled from the cylinders with the exhaust gases, still some of it is retained. This dust is undesirable because it promotes carbon deposits and may cause the parts to wear prematurely, due to its abrasive effect. An analysis of carbon deposits in cylinders has demonstrated that fully 50 per cent was due to road dust. As for the mechanical depreciation produced, this is well recognized by tractor makers, as these machines are always working in a cloud of dust in the field. To prevent untimely depreciation, the carburetor air intake is piped from an air filter box which keeps out most of the dust. These are made in various forms. The simplest is an ordinary large funnel covered over with an easily removable piece of coarse muslin, the funnel being attached to the air intake pipe. Another form is a cylindrical box shaped like a drum, the drum heads being rings covered with muslin or other cloth that will permit air to pass through but stop the gritty particles. The filtering cloth can be easily removed for cleaning by springing the retaining rings from the cylinder. The air intake of the carburetor is piped to the interior of the drum. Such devices are only practical with those types of carburetor having but one air entrance. A carburetor that has two or more air openings is harder to pipe up, as absolutely all air inspired by the motor must be filtered by the drum heads to keep the dust out. Such filtering devices are of obvious value and could undoubtedly be used to advantage on any truck operating constantly in dust laden air.

P. H. T. writes: "The motor in our truck occasionally runs as though there were water in the fuel. What is a simple method for detecting the presence of water in the gasoline?"

A. A hydrometer, which is, as you may know, an instrument for determining the specific gravity of any liquid, furnishes the most accurate instrument for detecting the presence of water in a fuel. However, as water is considerably heavier than gasoline, it will soon accumulate in the bottom of the tank, and the hydrometer will give only the specific gravity of the liquid in which it floats. A simple method for determining the presence of water in gasoline without the use of a hydrometer, consists in drawing off a small cupful from the bottom of the tank; if water is present it can probably be observed in the form of small globules in the bottom of the cup. If the contents are poured out upon some dry surface, such as a wooden floor, the pure gasoline will spread rapidly, but the water will retain its globular form, and will roll over the surface in a manner that renders the detection of the drops an easy matter. This furnishes one of the most conclusive proofs of the fact that oil (or gasoline) and water will not mix.

F. J. B. writes: "Information is requested as to the total number of automobiles and the total value of the American automobile manufacturers produce for the year 1913. I would appreciate very much if you can furnish me with this information—or direct me where same can be obtained."

A. It has been estimated that the total value of pleasure motor vehicles of American manufacture in 1913 was $400,000,000, that is, there were about 400,000 cars, and their average value was $1,000 each. About 60,000 motor trucks were manufactured at a value of about $2,000 each. The production of tires for the year is estimated at $100,000,000, and for magnetos about half that amount, although there may be some duplication in the last figure.

K. C. P. writes: "I have occasion to use my truck a good deal at night, and desire to install a simple form of electric lighting generator. I am familiar with nearly all of those of the better type, but find them too expensive for my purposes, and too difficult to install. What type would you suggest?"

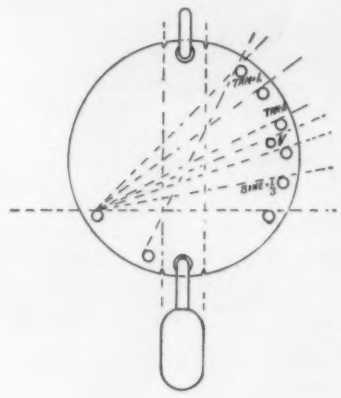
A. It is rather difficult to answer your question definitely without first knowing the make, size, and model of your truck, and other details of its design. From what you state, however, it is hardly probable that you are acquainted with one of the lowest-priced and simplest electric generators to be had. This is known as a fan type of generator, and is entirely self-contained in the hub of the fan. It is driven by the ordinary fan belt in front of the engine, and the new device entirely replaces the old fan, and can be easily attached to the original brackets.

RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Prime Movers and Their Accessories.

MUFFLER.—C. A. MILLER, Spring Valley, Ill. The invention relates more particularly to a muffler adapted for use in connection with combustion engines. It provides a plurality of baffle plates arranged in the casing of the muffler whereby the force of the exhaust gases



MUFFLER.

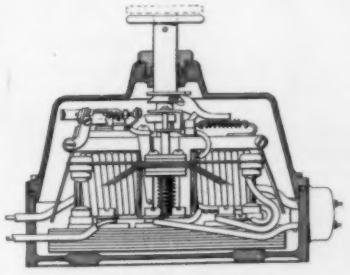
is retarded and the noise occasioned thereby reduced to a minimum. It also provides means whereby the baffle plates may be adjusted in order that the same may be cleansed by the force of the exhaust passing through the cylinder.

Pertaining to Aviation

FLYING MACHINE.—C. G. WALKER, Bramwell, W. Va. This invention relates to heavier than air flying machines, and the main object thereof is to provide such a device which closely imitates the flight of birds. Such flight is rendered possible by setting up a rotary, twisting motion in the air, by means of the wings, beneath and behind the bird, resulting in a swirling current of air which the inventor imitates by mechanical means, which means forms the basis of the present patent.

Electrical Devices

CIRCUIT BREAKER.—J. CUCULIC, 3110 Groverland Ave., Chicago, Ill. This invention relates generally to circuit breakers adapted for use in either direct current systems or alternating current systems, and more particularly it relates to a construction which will



CIRCUIT BREAKER.

operate automatically on overload or in the case of a short circuit, the construction and arrangement being such that the operation of the breaker will indicate whether or not there is voltage on the line.

Household Utilities

STRAINING DEVICE.—R. S. DARLING, care of Paramount Glass Percolator Mfg. Co., 24 Murray St., New York, N. Y. The object here is the provision of an arrangement whereby all metallic parts are eliminated. It provides a straining device for coffee percolators wherein the coffee receiving globe is formed with a groove for receiving a locking member, the same being associated with a straining device.

Machines and Mechanical Devices

HEAD MOTION.—W. A. STEDMAN, care of Mrs. W. A. Stedman, 702 33rd St., Oakland, Cal. The invention relates to head motions for concentrating tables, and has for its object the provision of a device as stated which is simple and efficient and which will reciprocate a concentrating table at variable speeds, the maximum of which speed is at one end of the table's travel.

BOOK SEWING MACHINE.—F. GAILER, 141 W. 24th St., New York, N. Y. In this invention the object in view is the provision of an improved book sewing machine for sewing signatures and fly leaves or linings together in a very simple and effective manner and without requiring the employment of highly skilled labor.

PUMP FOR VARIABLE SPEED HYDRAULIC TRANSMISSION GEARS.—C. BELLENS, No. 74 Rue Faider, Brussels-Ixelles, Belgium. The invention has for its object a pump system for variable speed hydraulic transmission gears with reverse, and serves particularly to increase the volumetric efficiency and the mechanical efficiency of this apparatus. It is applicable to all hydraulic transmissions whatever the principle or the application may be.

Of General Interest

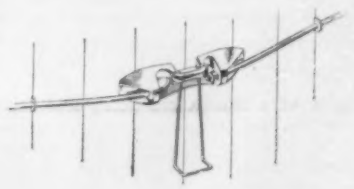
ROPE SOCKET.—G. A. MONTGOMERY, Box 76, Oilfields, Cal. The invention refers to sockets for well drilling cables or ropes. An object thereof is to provide a socket which can be used as a swivel or solid rope socket, which can be easily and quickly changed from one to the other, which is simple and strong in construction, which has its movable parts protected from abrasive material present in wells, and which movable parts within the socket are perfectly lubricated.

DRIVE SHOE.—G. A. MONTGOMERY, Box 76, Oilfields, Cal. The invention relates particularly to a drive shoe having reaming cutters, so that the shoe will ream its own way after the drill hole has been driven with a regular club bit. The shoe constitutes a reamer, and either entirely eliminates under-reaming, or makes the under-reaming operation unnecessary in many cases.

INK ERADICATOR.—K. W. MACPHERSON, Palmyra, N. Y. This invention has reference to ink eradicators, and the main object thereof is to provide a container for each of the two liquids used in ink eradication, and forming jointly a unit adapted to be carried in the pocket, handbag or the like.

LEAK STOPPER.—G. E. JUPP, 129 W. 21st St., New York, N. Y. This invention has for an object the provision of an improved construction designed to be temporarily used for closing portholes or openings of any kind in the side of a ship, the same being placed in position from the interior of the ship.

LADDER FOR STAVE STRUCTURES.—E. A. BERRY, 3217 Charlotte St., Kansas City, Mo. This invention relates to ladders for stave structures, such as silos, tanks, etc. An object is to provide a ladder for stave structures which is strong and inexpensive and which forms part of the tee hoops which



LADDER FOR STAVE STRUCTURES.

bind the stave structures. Another object is to provide a ladder the alternate steps of which form part of a lug engaged by the ends of a tee hoop, and the other step of a hoop depending from the lug.

SMOKING PIPE.—L. DEMUTH, 507 Broadway, New York, N. Y. This invention relates to smoking pipes which consist of a stummel and a detachable stem section. In smoking pipes of the indicated character, the detachable stem section is usually made of rubber or one of various compositions, and the great desideratum is to effect a proper air-tight connection between the stummel and the detachable section, which desideratum the improvement accomplishes.

ROTATABLE CIRCULAR BRUSH.—E. VAN DEVOORDE, Bremen, Germany. This brush is especially designed for the cleansing of surfaces, for instance, for scraping off of boiler incrustation, the removal of tightly adherent and hardened layers of rust from painted surfaces such as the outer plating of ships and the like. The brush for this purpose is not composed of separate flexible bristles or wires, but of stiff points which may be variously formed.

SAFETY ANCHORS FOR SUBMARINE MINES.—G. E. ELIA, Hotel de Crillon, Place de la Concorde, Paris, France. This invention relates to safety anchors for submarine mines, the object of the invention being to permit of the mine being manipulated without danger prior to its being submerged but insuring a rapid operative positioning when struck by a moving ship.

APPARATUS FOR THICKENING SLIMES.—W. A. STEDMAN, care of Mrs. W. A. Stedman, 702 33d St., Oakland, Cal. The improvement refers to the treatment of ores, as by the cyanid process, for the recovery of metals, and the main object thereof is to provide an apparatus which will remove excess water or solution from the slimes to thicken the same, after the slimes, or finely ground ores, have been mixed with water or solution to form pulp.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

The Man in the Multitude

That the human voice may be transmitted across our continent by telephone is the marvel of this age of wonders. Yet the full significance of the achievement is not realized if it is considered strictly as a coast-to-coast connection.

The Transcontinental Line not only bridges the country from east to west, but, by having finally overcome the great barrier of distance, it has removed the last limitation of telephone communication between all the people of the nation.

This means that the voice can be sent not only from New York to San Francisco, but from *anywhere* to *anywhere*—even from *any one* to *any one*—in the United States.

Wherever you are, it is possible to reach any one of our hundred million population. You can single out from this vast throng any particular individual with whom you desire to speak.

To bring this about, the Bell System has spent years and millions, extending its lines everywhere, anticipating the ultimate triumph. It has had the foresight and the courage to unite this great country, community by community, into one telephone neighborhood.

With success achieved by the Transcontinental Line, the established Bell highways make you, wherever you are, the near neighbor of your farthest-away fellow citizen.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
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One Policy *One System* *Universal Service*

DEAF?

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YOU CAN HEAR!

You see the wonderful improved Acousticon has now enabled 200,000 deaf people to hear. We are sure it will do the same for you; are so absolutely certain of it that we are eager to send you an

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Submarines Betrayed by Sound Waves

(*Concluded from page* 333)

affecting one transmitter and the increasing of the sound volume in another, indicating that the submarine is leaving one microphone zone and entering another. The arrangements for determining the distance between the shore and the hostile submarine are not revealed. The system is not available for use on vessels because of its extreme sensitivity.

There are said to be a large number of installations for the detection of submarines along the coast of England, Scotland and Ireland, and along the French coast bordering on the English Channel and extending as far west as the Bay of Biscay. These installations or stations are spaced at suitable intervals and provided with means for advising fast torpedo boat destroyers and armed motor boats of the presence of hostile submarines. Of the latter type of craft it is reported that some 2,000 are in use in the waters of the British Isles. These boats are capable of high speeds and are of such light draft that torpedoes are of no avail against them. They are sufficiently armored to withstand the fire of the guns carried by the latest German submarines.

Salvage of the Submarine F-4

(*Concluded from page* 337.)

a complete wreck and the scows from being washed up on the reef. The ground swell was followed shortly by heavy southerly weather. When, several days later, the sea had moderated sufficiently, divers were sent down to examine the condition of the vessel. A large rent was found in the hull forward where the chains from the leading scow had ripped through the shell plating. Lifting by the windlass method was now unsafe, as it was likely that the forward end of the submarine would break off under the strain.

A new plan was then adopted consisting of the use of six specially constructed pontoon cylinders. All of the cylinders were 32 feet long—four being 11 feet in diameter and two 12 feet 6 inches in diameter. The combined lifting capacity of the six pontoons was 420 tons. A margin of 100 tons was allowed for breaking the vessel away from the bottom, should there be considerable sand suction, and for the failure to realize all of the buoyancy available which would be occasioned by some of the cylinders becoming cockbilled to such a degree as to make it impossible to blow all of the water out of the high ends.

Each cylinder was divided at midlength by a transverse, water-tight bulkhead so as to facilitate control in sinking. A 4-inch flood and discharge valve was installed in each end bulkhead close to the bottom. Air valves were fitted on top of the cylinders for blowing out the water and venting each compartment. Eight feet from the ends, 12-inch hawse pipes were fitted through the pontoons.

The plan called for lifting the vessel by means of six chains,—the ends of the chains being brought up through the hawse pipes of the pontoons, three of which were to be placed on each side of the vessel. The chains were first of all worked under the submarine in predetermined positions,—two forward, two amidships and two aft. The two chains of a pair were spaced 16 feet apart so as to correspond to the distance between the hawse pipes. The pontoons were planted by means of a wrecking scow which was moored accurately over the submarine. The two cylinders of a pair were towed to the scene of operations and placed one on each side of the scow, directly over a pair of chains lying on the bottom.

The ends of the chains were now fished up through the hawse pipes and the cylinders submerged by opening the flood valves. They were kept under control while sinking by means of 5-inch manila lines made fast to the ends and taken to the hoisting engines on the scow. The process therefore consisted of threading the pontoons on to the chains. After they had landed on the bottom the chains were

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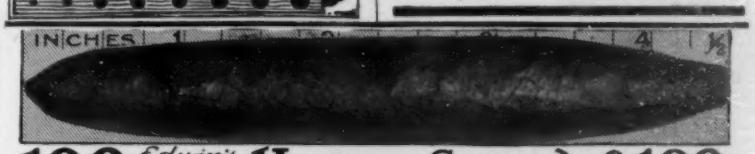

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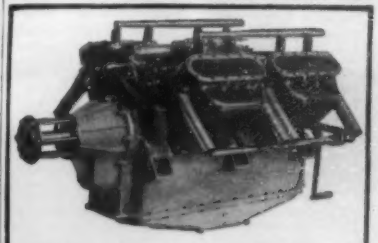
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adjusted so as to leave the necessary amount of slack to permit the pontoons to rise just clear of the vessel on becoming buoyant. A clamp was now fitted to each chain by the divers, just above the hawse pipe. The clamps consisted of two steel castings, molded to the shape of the chain links and of such length that they spanned the hawse pipes. By means of four heavy bolts the two halves of the clamp were drawn together. These bolts kept the clamps from spreading and the chain from slipping through when subjected to the lifting strain.

After all six cylinders had been landed on the bottom alongside of the vessel and the clamps had been secured by the divers, the unwatering process was started. For this purpose torpedo air flasks, charged to a pressure of 2,150 pounds, were placed on a coal barge. The flasks were piped to an expansion chamber which in turn was connected to a manifold. Twelve ¾-inch air hose lines were led from the manifold valves to the blow-out valves on top of the pontoons. The coal barge was moored about 50 feet to one side of the location of the submarine so as to be clear when the latter rose to the surface. A pressure of 35 pounds was used at the manifold for blowing out the water while the cylinders were resting on the bottom. The unwatering operation had to be watched very carefully so as to avoid the danger of blowing out the heads of the cylinders on emerging.

The method proved successful in every detail. The work of placing the chains under the submarine was started on August 21st. All of the chains were in position on August 25th. It then took one day to place each pair of cylinders. This could be done only during daylight, as, naturally, the divers could not work in the dark. On August 29th everything was ready for blowing the water out of the pontoons. This operation took about two hours from the time the air was turned on. One end of the submarine came up slightly ahead of the other, as was to be expected. The vessel was towed into the harbor suspended from the six pontoons, and was docked the following day.

The pontoon method which was finally adopted could not have been used originally for bringing the vessel to the surface because of the great depth of water in which the submarine lay at first. The divers had to work under water from five to nine hours a day from August 21st to August 29th while placing the chains under the vessel, securing the clamps after the pontoons had been lowered, closing flood and vent valves, and, later on, connecting the hose leads for blowing out. This work could not have been done at a depth of 300 feet, as most of it was extremely arduous and fatiguing.

Electrical Exposition and Motor Show of 1915

(Concluded from page 339.)

plying electricity to every conceivable task incidental to maintaining a bachelor apartment, as well as for the maximum enjoyment, this exhibit was well staged to demonstrate the extremes to which electric current can be applied in solving the home problem.

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The Largest Arch Bridge in the World

(*Concluded from page 341.*)

at the panel points, the suspension members, to the bottom of which will be attached the floor beams, which are 9 feet in depth by 93 feet in length. The main arches are in vertical planes 60 feet apart and the longitudinal portion of the floor system consists of eight lines of stringers, or two beneath each of the four lines of railroad tracks. Above the stringers is laid a solid concrete floor. On this will be laid 14 inches of stone ballast, in which will be embedded the ties. It should be mentioned here that the floorbeams are the heaviest ever built for a bridge.

The wind bracing is carried in the planes of the upper and lower chords and in the plane of the roadway. The maximum compression in the arch is found at the bearing, where it amounts to 14,300 tons; at the crown it amounts to 8,000 tons. This compression is due to the combined dead and live load, wind pressure, and the temperature strains.

Stretcher Hammock and Stretcher Chair

(*Concluded from page 342.*)

of canvas 15 inches wide in the form of a chair, the seat of which is held with iron braces. One end of the canvas is fastened to the shoulders of the forward stretcher bearer with canvas straps, thus forming the back of the chair. The other end of the canvas is looped to form a foot rest for the wounded man. Canvas straps from the handles of the chair go over the shoulder of each stretcher bearer, relieving them of the weight on their hands. Fractured arms and legs are laced in braces specially made for the purpose.

Both the stretcher hammock and the stretcher chair has been adapted in the army of the Allies. Stretcher bearers become very skilful and one will often see them run across an open place or a break in the trenches under fire, carrying a heavy wounded man, as part of the day's work, apparently without fear, and then enter a long narrow passage, of a never-ending trench, carefully taking their charge to a place of safety.

Notes for Inventors

Patent Number 1,149,309 to W. Von Phul, A. L. Black and A. M. Lockett, assignors of New Orleans, La., and patent No. 1,149,310 to W. Von Phul of New Orleans, assignor, are for bale or package removing mechanisms in which means are provided for operating below superposed bales to relieve the pressure thereof, and co-operating means are provided for forcing a lower bale out of the pile. This is useful in cases where it is desired to withdraw or remove individual bales or other packages from those above.

A Lake Submarine Boat Patent.—Simon Lake, of Milford, Conn., assignor to the Lake Torpedo Boat Co., has secured patent, No. 1,149,373, for a submarine boat in which the object is to provide a novel arrangement of driving mechanism for operating the propellers, where the engine room is of restricted area. So that greater power may be obtained, the power is applied directly to the propeller shaft in separate units, with the unit of power arranged and distributed so as to suit the speed of the vessel when operating upon or entirely below the surface of the water.

The Inventor and the Puncture-proof Tire.—A practical man in the rubber tire industry in a recent publication speaks of the lure of a non-puncturable tire to the mind of an inventor, and he refers to the fact that a knowledge of the technics of the tire industry does not seem necessary to the production by an inventor of a useful device, as at times one unfamiliar with the industry may develop valuable improvements that have been overlooked by those trained in the particular art. This should be encouraging to inventors who have not first-hand expert knowledge of tire production.

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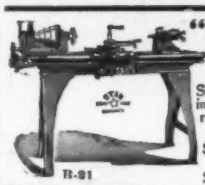

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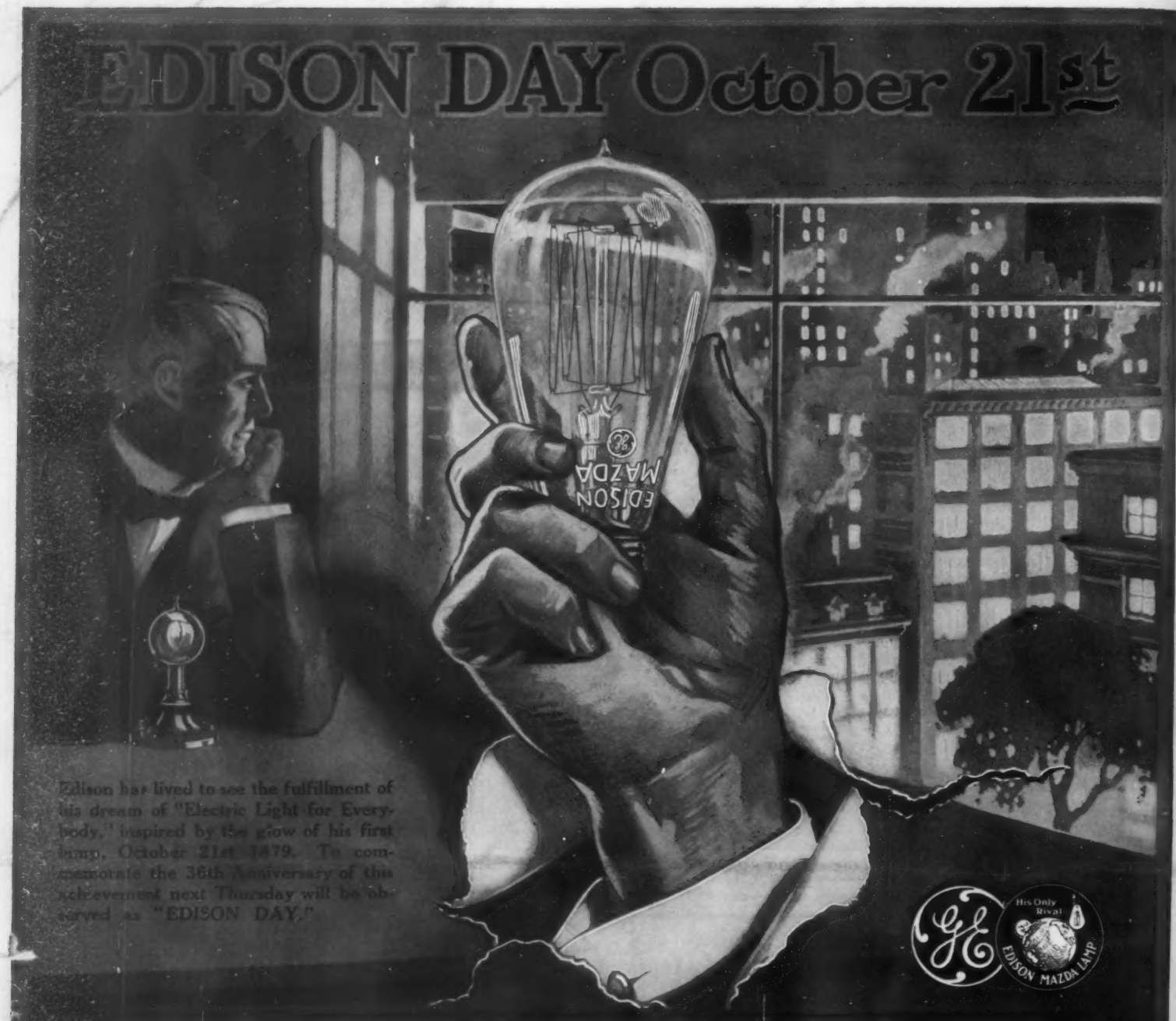

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